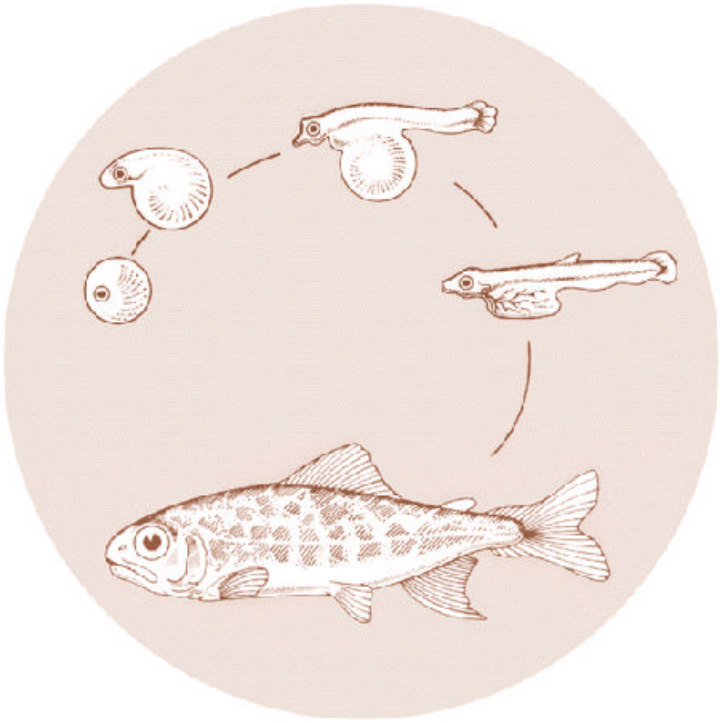
November 1999

UMATILLA HATCHERY MONITORING AND EVALUATION

(NOVEMBER 1, 1997 - OCTOBER 31, 1998)

Annual Report 1998



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UMATILLA HATCHERY MONITORING AND EVALUATION

ANNUAL REPORT 1998
(NOVEMBER 1, 1997 - OCTOBER 31, 1998)

Umatilla Hatchery Monitoring and Evaluation

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EXECUTIVE SUMMARY

This report summarizes monitoring and evaluation studies of salmonids reared at Umatilla Fish Hatchery (UFH) for the period November 1, 1997 to October 31, 1998. Studies at Umatilla Hatchery are designed to evaluate rearing of chinook salmon and steelhead in "Michigan raceways". Characteristics of Michigan raceways include high fish densities, rapid water turnover, oxygen supplementation, reuse of water, and baffles designed to reduce cleaning. Fish health at UFH and other facilities associated with the Umatilla program are intensively monitored and evaluated as part of the overall research project. Further, under the Integrated Hatchery Operations Team guidelines, specific requirements for fish health monitoring are mandatory and have become the responsibility of the fish health staff conducting studies at UFH. Additional studies include evaluations of sport fisheries in the Umatilla River and mass marking and straying of fall chinook salmon. Except for adult recovery data, an experiment designed to evaluate rearing subyearling fall chinook salmon in Michigan and Oregon raceways has been completed. We are currently in the second year of rearing subyearling fall chinook salmon at three densities. Experimental rearing of subyearling, fall release, and yearling spring chinook salmon, and steelhead has also been conducted. Although preliminary adult return data has been recovered, data on smolt-to-adult survival for all groups is incomplete. Conclusions in this report should be viewed as preliminary and used in conjunction with additional data as it becomes available.

Objectives for Fiscal Year 1998

Hatchery Monitoring and Evaluation

1. Document egg-take, egg-to-fry, and egg-to-smolt survival for salmon and steelhead reared at UFH and released in the Umatilla River.

2. Document rearing density, loading, and cost of salmon and steelhead reared at UFH. Document rearing density and loading for salmon and steelhead reared at Bonneville, Carson, Little White Salmon, and Willard hatcheries and released in the Umatilla River.

3. Document number, size, time, and release location for salmon and steelhead reared at Umatilla, Bonneville, Carson, Little White Salmon, and Willard hatcheries and released in the Umatilla River.

4. Monitor water quality in Michigan and Oregon index raceways containing salmon and steelhead.

5. Collect and compare monthly length, weight, and condition factor estimates for salmon or steelhead reared in Michigan and Oregon raceways at UFH.

6. Calculate growth for salmon and steelhead reared in Michigan and Oregon raceways at UFH.

7. Determine length, weight, condition index, smolt status, descaling, and fin condition at pre-release or release for salmon and steelhead reared at Umatilla, Bonneville, Carson, Little White Salmon, and Willard hatcheries and released in the Umatilla River.

8. Determine and compare survival and blood sodium of spring chinook salmon reared at Umatilla and Little White Salmon hatcheries and challenged with sea water.

9. Evaluate smolt migration performance of PIT-tagged salmon or steelhead reared at Umatilla, Bonneville, Carson, Little White Salmon, and Willard hatcheries, released in the Umatilla River and recovered at John Day dam.

10. Evaluate smolt-to-adult survival rates (SAR) of salmon and steelhead by coded-wire-tagging.

11. Summarize catch and escapement and life history data from coded-wire-tagged salmon and steelhead released in the Umatilla River.

12. Evaluate straying of adult fall chinook salmon produced from the Umatilla River.

13. Evaluate and compare the effects of tagging and marking on SAR of subyearling fall chinook salmon.

14. Participate in the development of water quality sampling and monitoring in the Umatilla River basin.

15. Estimate the sport harvest of salmon and steelhead in the Umatilla River with statistical creel methods.

16. Participate in production and management planning activities for anadromous fish in the Umatilla River basin.

Fish Health Monitoring and Evaluation

1. Conduct monthly fish health examinations on five fresh-morbid or moribund juvenile fish from index raceways of each species and stock reared at Umatilla Hatchery.

2. Conduct monthly fish health examinations on five grab-sampled juvenile fish from the lower raceway of each chinook salmon series at Umatilla Hatchery.

3. Conduct preliberation fish health examinations on 30 grab-sampled yearling chinook salmon per evaluation raceway at Umatilla Hatchery four weeks prior to release.

4. Conduct preliberation fish health examinations on ten grab-sampled yearling steelhead per raceway at Umatilla Hatchery four weeks prior to release.

5. Develop disease profiles of fish reared under differing conditions and make comparisons among rearing strategies.

6. Examine fish when unusual loss or behavior occurs using appropriate diagnostic methods. ..Implement therapeutic or prophylactic measures to control, moderate, or prevent disease outbreaks.

7. Continue implementation of Federal Drug Administration Investigational New Animal Drug protocols, including prophylactic feeding of Aquamycin to spring chinook salmon juveniles at Umatilla Hatchery.

8. Continue implementation of prophylactic and therapeutic treatments, either under Federal Drug Administration Investigational New Animal Drug protocols or prescriptions for oxytetracycline, erythromycin, formalin, and Chloramine-T, as needed for disease treatments of all species, ages, and stocks at Umatilla Hatchery, Minthorn Ponds, South Fork Walla Walla Adult Facility, and Three Mile Dam Adult Facility.

9. Examine fish at Thornhollow and Imeques C-mem-ini-kem acclimation facilities during periods of increased loss or for preliberation following transfer from Umatilla Hatchery, Little White Salmon NFH, and Willard NFH.

10. Collect *Renibacterium salmoninarum* and culturable virus data from up to twenty spawned females, per spawning date, per species providing eggs for Umatilla Hatchery.

11. Analyze data from broodstock sampling to anticipate potential disease problems in progeny and develop subsequent control recommendations or possible treatments.

12. Continue to develop expertise in statistical analysis pertinent to the epidemiological evaluations at Umatilla Hatchery. Use this to analyze trends in all data accumulated to date.

13. Monitor coded-wire tag spring chinook salmon adults, which originated from juveniles reared at Umatilla and Bonneville Hatcheries and returned to the Umatilla River, for *Renibacterium salmoninarum.*

Accomplishments and Findings for Fiscal Year 1998

Hatchery Monitoring and Evaluation

We achieved all of our objectives in fiscal year 1998. To monitor the downstream migration of juvenile fish, we PIT-tagged fish for the first time in 1998.

Fall Chinook Salmon

Subyearlings, Rearing in Michigan and Oregon Raceways: Smolt-to-adult survival of the 1991 brood was less than 0.01%. Data for the 1992-93 broods suggests survival rates of less than 0.1%. Small sample sizes may limit statistical comparisons; however, preliminary analysis suggests similar survival rates for fish reared in Michigan and Oregon raceways and among groups reared in first, second or third pass Michigan raceways.

Subyearlings, Density Studies in Michigan Raceways: Subyearlings were reared at three densities for the second year in 1998. Over two million subyearling fall chinook salmon were reared in Michigan raceways and released in the Umatilla River. Production exceeded the 1998 fiscal year goal (2.6M) and was within 11% of the size goal of 60 fish/lb. Cumulative densities in three Michigan raceways produced 668, 975, and 1,286 fish/gpm in low, medium, and high density series. Combined rearing and marking costs were $0.17/fish. More than 2 million salmon were coded or blank wire-tagged in 1998 (>97% retention). The ventral fin clip quality was greater than 95% recognizably clipped and descaling was similar (0-11%) for fish reared in high, medium or low density raceways. We PIT-tagged approximately 500 fish from each raceway to monitor juvenile migration. The number of tagged fish recovered at John Day (JD) Dam ranged from 21-34 fish for each group resulting in recovery of 4.2-6.5%. Fish that were largest at tagging had the highest detection rates. No differences in travel time were observed for fish reared at different densities. Smolts required an average of 17-22 days to travel to JD Dam.

Yearlings (Bonneville Hatchery/Willard Hatchery): More than 259,000 yearlings (1996 brood) were reared at Bonneville Fish Hatchery (BFH) and released in the Umatilla River. Production was greater than the 1998 fiscal year goal (255K) and the release weight of 10.8 fish/lb was smaller than the 10.0 fish/lb goal. All yearlings were coded or blank wire-tagged (>97% retention). We estimated that 56% of the fish reared at BFH were partially descaled or descaled. We PIT tagged 219 fish to monitor juvenile migration in 1998 and fourteen fish were detected at JD dam for a 6.4% recovery rate. Adult survival of fish reared at BFH and released in the Umatilla River ranged from 0.00-0.04% for the 1990-91 broods. Preliminary estimates of survival for the 1992 brood is 0.1%, and it is unlikely the 0.75% return goal will be reached

Approximately 99,000 yearlings were reared at Willard Fish Hatchery (WFH) and released in the Umatilla River in 1998. Production was below the 1998 fiscal year goal (225K). The release weight of two groups of fish were 15.6 fish/lb and 11.6 fish/lb, both were smaller than the size at release goal (10 fish/lb). We estimated that more than 90% of the fish reared at WFH were partially descaled or descaled. We PIT tagged two groups of approximately 250 fish to monitor juvenile migration in 1998. The number of fish detected at JD dam was 38 for an 8.6% recovery rate. No estimates of adult survival for previously released groups were available.

Adult Returns to the Umatilla River: Counts of fall chinook salmon at Three Mile Falls Dam (TMFD) in 1997 were 354 adults, 207 jacks, and 189 subjacks. Adult returns peaked in early-October. Based on CWT recoveries, both subyearling and yearling releases contributed to adult returns, but all subjacks originated from yearling releases. The adult run prediction for 1998 was 463 fish (range 335-590).

Fishery: Anglers fished 2,742 h for fall chinook and coho salmon in 1997. Catch rates for fall chinook salmon jacks and adults were 0.06 and 0.02 fish/h and anglers harvested 181 jack and 11 adult fall chinook salmon. Catch rates for coho salmon averaged 0.03 fish/h and 0.02 fish/h for jacks and adults. Anglers harvested 134 jack and 37 adult coho salmon. We estimated that 47% (181/388) of the jack fall chinook salmon and 18% (171/974) of the coho salmon that entered the Umatilla River were harvested between TMFD and the mouth.

Straying: Monitoring showed that most wire-tagged fish from Umatilla releases were removed at Lower Granite Dam. We estimated that 21 jacks and 19 adults escaped past Lower Granite Dam in 1997. Most Umatilla "strays" originated from 1993 brood subyearlings that were reared at UFH.

Spring Chinook Salmon

Subyearlings: No subyearling spring chinook salmon were reared at UFH in 1997-98. Previous releases have been unsuccessful. Only one coded-wire-tagged fish has been recovered from subyearlings released from 1992-94.

Fall Release: No fish were reared for fall release in 1998. Few CWT's have been recovered from releases made from 1992-94. Survival rates for the 1991 brood reared at UFH were 0.00-0.01% compared to survival rates of 0.01-0.04% for fish reared at BFH. Preliminary survival estimates of the 1992-93 broods reared at UFH range from 0.00-0.08%. Moreover, current survival rates for the 1993 brood are greater than survival rates for spring release yearlings.

Yearlings:

Umatilla Hatchery: Approximately 383,000 yearling spring chinook salmon were reared at UFH and released in the Umatilla River in 1998. This was greater than the 1998 fiscal year goal (360K). Fish were released at 11.2-12.0 fish/lb, near the 12 fish/lb goal. Rearing and marking costs were $0.34/fish. Approximately 161,000 fish were coded wire-tagged for release (96% retention). Fish condition was 17-25% partially descaled or descaled.

Results from a salt-water challenge test (30 ppt) suggested little difference in plasma sodium between fish reared at Umatilla or Little White Salmon hatcheries. Plasma sodium concentrations (mM) after exposure to salt-water increased approximately 37% in Umatilla reared fish and 47% in fish from Little White Salmon.

We PIT tagged approximately 250 fish each from four Oregon and three Michigan raceways to monitor juvenile migration in 1998. The percentage of fish detected at JD Dam ranged from 7-12% for fish reared in Michigan raceways and 4-11% for Oregon reared fish. The median travel time for both groups ranged from 44-49 d.

Smolt-to-adult survival of yearlings reared at UFH continues to be poor. Through 1998, survival rates for 1991-93 broods reared at UFH have ranged from 0.04-0.06% compared to rates of 0.22-0.56% for fish reared at BFH.

Little White Salmon Hatchery: Approximately 345,000 yearlings were reared at Little White Salmon Hatchery and released in the Umatilla River in 1998, slightly less than the goal of 350,000. Half the fish were released at 15.7 fish/lb and half were released at 11.4 fish/lb compared to a release goal of 12 fish/lb. Relative survivals of PIT-tagged fish were 3% for a group released in March and 10% for an April release. No adult survival data was available.

Carson Hatchery: The goal to rear 100,000 yearlings at Carson Hatchery for release in the Umatilla River was met in 1998. The release size was 16.2 fish/lb, below the goal of 15 fish/lb. Relative survival of PIT-tagged fish was 12% for an April release. No adult survival data was available.

Adult Returns to the Umatilla River: We predicted an adult run of 509 spring chinook salmon to the Umatilla River; actual run size was 409 adults and 20 jacks in 1998. Adult returns peaked in mid-May and analysis of CWT data indicated the majority of returning adults were from the 1993 brood reared at BFH. Based on 20 jacks we predicted a run of 731 adults (267-1,195 95% CI) in 1999

Fishery: The sport fishery for spring chinook salmon was not open during 1998.

Summer Steelhead

Approximately 137,000 steelhead were released in the Umatilla River in 1998. Steelhead production was lower than the 1998 fiscal year goal (150,000). Size-at-release ranged from 4.7-5.9 fish/lb and fish from two of three raceways were smaller than the 5 fish/lb goal. Combined rearing and marking costs were $0.67/fish. Approximately 61,000 fish were CWT in 1997-98 (>93% retention) and all fish were adipose fin-clipped. We estimated 4-39% of the fish were partially descaled or descaled when released.

We PIT tagged approximately 250 fish from each raceway to monitor juvenile migration in 1998. The number and percent detected at JD Dam ranged from 21-44 and 9-18% per raceway.

Coded-wire tag data continues to suggest greater SAR for groups released in April than for the group released in May. Completed data for the 1992-94 broods showed recovery rates ranging from 0.5-1.1% for April releases compared to 0.0-0.2% for May releases.

Adult Returns to the Umatilla River: The number of steelhead counted at TMFD in 1997-98 was 1,762. Returns of hatchery fish (904) were the second greatest on record and run timing continued to emulate the wild fish. Hatchery fish were 59% female while wild fish were 69% female. Of 87 fish sampled for CWT's we found 18 hatchery strays and by expansion we estimated that 12% (204/1,762) of the total Umatilla run were strays.

Fishery: We estimated that anglers fished 6,676 h in 1997-98. In the lower river anglers fished a total of 3,727 h for a catch rate of 0.06 fish/h and a harvest of 89 ± 50 fish (95% CI). In the upper river anglers fished 2,949 h for a catch rate of 0.05 fish/h and a harvest of 101 ± 52. We estimated that 5% of the steelhead entering the Umatilla River were harvested between TMFD and the mouth of the Umatilla River.

Fish Health Monitoring and Evaluation

Broodstock Monitoring

Infectious Hematopoietic Necrosis Virus (IHNV) was isolated from 30/81 (37%) females and 8/21 (38.1%) males sampled from Ringold spring chinook salmon 98 brood year fish held and spawned at Little White Salmon NFH on a day when eggs were collected for Umatilla Hatchery 98 brood year production.

All Umatilla River returning 98 brood year summer steelhead, 97 brood year fall chinook and 98 brood year spring chinook were negative for culturable viruses; the Priest Rapids 97 brood year fall chinook were also negative for culturable viruses.

Only one case of clinical bacterial kidney disease (BKD) was found among all adult Umatilla River spring chinook assayed for *Renibacterium salmoninarum* (Rs) by the enzyme-linked immunosorbent assay (ELISA) for the 98 brood year at the South Fork Walla Walla Facility. Two of 16 (12.5%) selected female Ringold spring chinook salmon used for Umatilla Hatchery 98 brood year production had moderate levels of Rs antigen by the ELISA.

All 97 brood year fall chinook salmon at Three Mile Dam Adult Facility had only negative or low levels of Rs antigen by the ELISA.

A high prevalence (60%) of *Aeromonas salmonicida*, the causative agent of furunculosis, was documented in adult fall chinook mortalities at the Three Mile Dam Adult Facility in 1997.

Juvenile Monitoring

There were no juvenile disease outbreaks during this report period at Umatilla Hatchery. Bacterial kidney disease was present at low levels in the 96 brood year Carson spring chinook salmon as evidenced by the detection of only 11 fish with clinical levels of BKD throughout all of the monthly monitoring examinations.

The bacterial agent of cold water disease (CWD), *Flavobacterium psychrophilum*, was occasionally isolated during monthly monitoring examinations from the 97 brood year summer steelhead and the Priest Rapids 97 brood year subyearling fall chinook. A first time isolation at Umatilla Hatchery of the bacterial agent of enteric redmouth disease, *Yersinia ruckeri*, was made from a 97 brood year summer steelhead.

A preliberation/increased loss examination of 96 brood year fall chinook salmon yearlings at the Thornhollow acclimation ponds revealed an extremely high prevalence (100%) of BKD in the mortality examined. Also contributing to the loss was CWD bacteria which were found in moderate to high levels in 40% of the mortalities.

Significant levels of Rs antigen and some clinical BKD by gross observation were found in all three release groups of 96 brood year Carson spring chinook salmon examined at the Imeques C-mem-ini-kem acclimation site. Varying levels of CWD bacteria were also detected in these same three release groups.

All juvenile examinations for culturable viruses at Umatilla Hatchery were negative.

Prophylactic Treatments

Two erythromycin (Aquamycin) feedings were given to the 96 brood year spring chinook salmon at Umatilla Hatchery. Non-lethal signs of toxicity were observed following the first treatment; lethal and

non-lethal signs were observed during the second feeding and on days one, three and seven of toxicity testing.

Management Implications and Recommendations

Hatchery Monitoring and Evaluation

1. Preliminary estimates of SAR for subyearling fall chinook salmon reared in MI and OR raceways and in different MI passes appear similar. However, adult survival has been poor and the number of CWT's recovered may not be adequate (required N=35) to perform statistical tests.

2. Juvenile performance from the 1996-97 broods suggests rearing subyearling fall chinook salmon at high densities is successful. As designed, the high density Michigan series produces 33% more fish (1.2 M) than the standard MI series (0.9 M) and at a survival rate of 0.30% would produce 900 more adults. Moreover, the rearing environment, fish quality, and smolt migration of subyearlings reared at three densities appears to be similar.

3. Determining the outmigration success of subyearling fall chinook salmon to accurately assess whether poor SAR is related to fish quality or environmental conditions in the migration corridor is critical. Percent detection of PIT-tagged fish at JD dam averaged 5.1-5.8% for all groups but was greater for fish that were larger at tagging. We recommend conducting studies to determine the optimum size, time, and location to release juveniles. Pilot studies with PIT-tagged fish should be used to provide preliminary information to guide future experiments.

4. The study to examine the effects of tagging and marking on survival of subyearling fall chinook salmon is complete. Statistical analysis of the returns from the 1991 and 1992 broods were not conducted because of small sample sizes. In both broods, the survival of fish marked only once with a left ventral (LV) clip or body tag (BT) appeared to be greater than fish marked twice (BT+LV or AD+CWT). Moreover, when survival rates were ranked by mark, the pattern was similar in each year. Greatest survival was found for fish marked BT only, followed by LV, AD+CWT, and LV+BT. This study was hindered by poor experimental design that did not allow clear identification of marked groups, low recovery rates to TMFD, and problems associated with tag detection. Because the use of body tags was costly and labor intensive, no further study is warranted or suggested at this time.

5. Recent SAR of fall chinook salmon released as yearlings is poor. Moreover, the current release strategy (10 fish/lb) produces a high proportion of males returning as age 2 jacks. The number of smolts lost for adult production because of early maturation should be determined. Time and size-at-release experiments designed to reduce the production of subjacks and improve adult return rates could be considered if this problem is identified as significant.

6. Subyearling and yearling release strategies for fall chinook salmon in the Umatilla River should be reevaluated. Both strategies contribute adults, but neither strategy contributes consistently. Each rearing strategy should be evaluated for adult contribution and cost per adult. Adults returning from subyearling releases continue to stray, while juveniles released as yearlings stray less but produce subjacks that may substantially reduce adult production.

7. Fall chinook salmon straying remains a concern and constitutes a loss of escapement to the Umatilla River and a significant risk to the Snake River population. If added to the Umatilla returns, strays to

the Snake River would have increased the run by 20%. Methods to reduce straying and increase returns to the Umatilla River should be investigated. If straying could be reduced to an acceptable level, the need to mark all Umatilla stock would be eliminated and production costs would decrease substantially. We suggest monitoring physiological measurements of smolt development to evaluate imprinting.

8. Production of yearling spring chinook salmon at UFH should be reevaluated. Data continues to indicate greater survival for yearlings reared at BFH than at UFH. However, recent changes in the rearing profile have produced a smolt that is smaller and similar to smolts reared at BFH. We recommend incubating eggs at temperatures throughout embryo development to produce smaller juveniles at release and monitoring SAR.

9. Production of steelhead in Michigan raceways should continue. Michigan raceways have performed well by most measures since densities were reduced from about 6 lb/ft^3 to 4 lb/ft^3 following the 1991 brood. Although we have not concurrently reared steelhead in Michigan and Oregon raceways, we estimate 40% greater juvenile production in Michigan raceways per gallon of water. Studies with simultaneous rearing of steelhead in Michigan and Oregon raceways need to be completed before the effectiveness of the Michigan system can be fully evaluated.

10. The contribution of graded small steelhead to the production goals should be re-evaluated. Survival of graded large steelhead has averaged 0.83% compared to 0.13% for graded smalls. PIT-tag recovery data also suggests poor juvenile survival for the small steelhead compared to larges. We recommend a volitional release strategy for all groups. We should also consider acclimating the small group lower in the river (Minthorn) where they can be released into the mainstem. The current release site (Bonifer Pond, Meacham Creek) introduces them into a tributary stream which may encourage residency. PIT-tag, radio-telemetry or marking and snorkeling studies could provide needed information on the juvenile migration success and the residualism associated with the various release groups.

11. Rearing small-grade steelhead should be reevaluated to identify fish culture and management strategies that could improve SAR. The graded smalls produce few adults in relation to the time and effort required for rearing. Possible options include changing feed to increase growth rates or altering release times and locations. Increased survival would help to achieve the adult return goals outlined in the master plan.

12 Increased effort should be directed at determining the success of the steelhead hatchery program to the supplementation goal. Information on the distribution and interactions of hatchery and natural spawners should be broadened by radio-tracking adults to their spawning grounds. More information is needed on the availability and use of winter habitat by juvenile steelhead in the Umatilla River

13. The UFH program has been successful at providing a steelhead fishery on the Umatilla River. Estimated angler hours has remained between 4,500 and 6,700 since creel surveys were initiated in 1992. Our creel survey likely underestimated steelhead catch and harvest and should be viewed as an index for documenting long term trends. Harvest estimated from punch-card data has been two to five times higher than creel estimates. Recconaisance aerial surveys at key times should be considered to more accurately estimate the amount and distribution of angling effort in the unsurveyed river.

14. Alternative water supplies should be investigated at UFH. Partial justification for the construction of UFH was to compare the adult survival of salmonids reared in Michigan and Oregon raceways.

Water shortages at the UFH continue to limit production and experiments that could produce information for other Columbia River basin hatcheries.

Fish Health Monitoring and Evaluation

1. Continue implementing the practice adopted in 1997 of culling eggs and/or pursuing segregated rearing strategies if needed, based on Rs in the female parent. This means continued sampling of 100% of the female adult chinook salmon for Rs. This will help in reducing the impact of bacterial kidney disease (BKD) on restoration efforts.

2. Continue efforts to sample 100% of coded-wire tagged returning adult chinook salmon in to obtain statistical comparison of Rs infection levels versus rearing strategy, including hatchery of origin.

3. Implement and maintain rearing strategies that seek to reduce stress and/or evaluate the effects of potential stress reducing rearing strategies.

4. Minimize or eliminate the practice of stocking fish into the Umatilla basin, known to have significant prevalence of serious salmonid pathogens, in order to minimize the impact on natural or other hatchery-produced fish.

5. Prophylactic injections of oxytetracycline (OTC) should be considered in future years to reduce ..the infection rate and the pre-spawning mortality due to furunculosis. Prophylaxis should be .... given as intraperitoneal injections of OTC at a dosage of 10 mg per Kg of fish body weight. This .....injection should be administered at the time the fish are sorted into the holding ponds.

6. Seek ways to maximize the benefit of erythromycin (Aquamycin) medicated feeding while reducing the toxic effects that have been observed.

REPORT A

Umatilla Hatchery Monitoring and Evaluation

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OREGON DEPARTMENT OF FISH AND WILDLIFE

INTRODUCTION

The Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program authorized construction of Umatilla Hatchery (UFH) in 1986. Measure 703 of the program amended the original authorization for the hatchery and specified evaluation of the Michigan (MI) raceways using oxygen supplementation to reach production goals of 290,000 lb of chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*). The hatchery was completed in fall 1991. Partial justification for the hatchery was to develop considerable knowledge and understanding of new production and supplementation techniques. MI raceways were used at UFH to increase smolt production with a limited water supply and for comparison of MI raceways with Oregon (OR) raceways. Test results for MI raceways will have systematic application in the Columbia River basin.

The Umatilla Hatchery is the foundation for rehabilitating chinook salmon and enhancing steelhead in the Umatilla River (CTUIR and ODFW 1990) and is expected to contribute significantly to the Northwest Power Planning Council's goal of doubling salmon production in the Columbia Basin. Hatchery production goals and a comprehensive monitoring and evaluation plan were presented in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990). The Comprehensive Plan for Monitoring and Evaluation of Umatilla Hatchery (Carmichael 1990) was approved by the Northwest Power Planning Council as a critical adaptive management guide for fisheries rehabilitation in the Umatilla River. Monitoring and evaluation will be used to increase knowledge about uncertainties inherent in the fisheries rehabilitation and will complement the developing systematic monitoring and evaluation program.

The monitoring and evaluation goals are:

1. Provide information and recommendations for the culture and release of hatchery fish, harvest regulations, and natural escapement to accomplish long-term natural and hatchery production goals in the Umatilla River basin that are consistent with provisions of the Council's Columbia River Basin Fish and Wildlife Program.

2. Assess the success of achieving the management objectives in the Umatilla River basin that are presented in the Master Plan and the Comprehensive Rehabilitation Plan.

A substantial proportion of the production at UFH is reared in MI raceways. This system has not been thoroughly evaluated to determine the effects on SAR. In addition, the rearing strategies proposed for spring chinook salmon require an unusually extensive period of incubation in chilled well water.

Extensive background and justification for UFH monitoring and evaluation is presented in Carmichael (1990). In this report, we present a review of our activities and findings for the UFH Monitoring and Evaluation Project from November 1, 1997 to October 31, 1998. We designed our program to evaluate fish cultural practices, conduct rearing and survival studies, assess sport fisheries, and provide information for planning and coordination. Additional studies have been designed for fall chinook salmon to evaluating straying and the effects of tagging.

We monitored the culture and performance of more than 3.2 million chinook salmon and steelhead produced at UFH in 1997-98 (Appendix Tables 2-8). Individual stock profiles, release, performance, and return data of previously released groups are presented in the following sections.

STUDY SITE

Umatilla Hatchery is located approximately seven miles west of the town of Irrigon, Oregon. The hatchery is operated under a cooperative agreement among the Oregon Department of Fish and Wildlife (ODFW), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), the Bonneville Power Administration, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.

The hatchery was designed to produce salmonids in oxygen supplemented MI raceways and in non-oxygen supplemented OR raceways. Specific data about the hatchery is available in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990) and in the Environmental Assessment Report (Bonneville Power Administration 1987). The MI system consists of eight series of three concrete raceways. Water flows from the upper raceway to the middle raceway and then to the lower raceway within each series. Before the water enters each raceway, pure oxygen is supplemented through an oxygen contact column. More detailed descriptions of the raceways are presented in Focher et al. (1998).

The Umatilla River and tributaries are located in Umatilla, Morrow, and Union counties, Oregon. Broodstock facilities are located at TMFD (fall chinook and coho salmon), South Fork Walla-Walla River (spring chinook salmon), and Minthorn Springs (MS) at river mile 64, Umatilla River. Acclimation facilities include MS, Thornhollow (TH) at river mile 73.5, Imeques C-mem-ini-kem (IC) at river mile 80, and Bonifer Springs (BS) at river mile 2 of Meacham Creek (Figure 1).

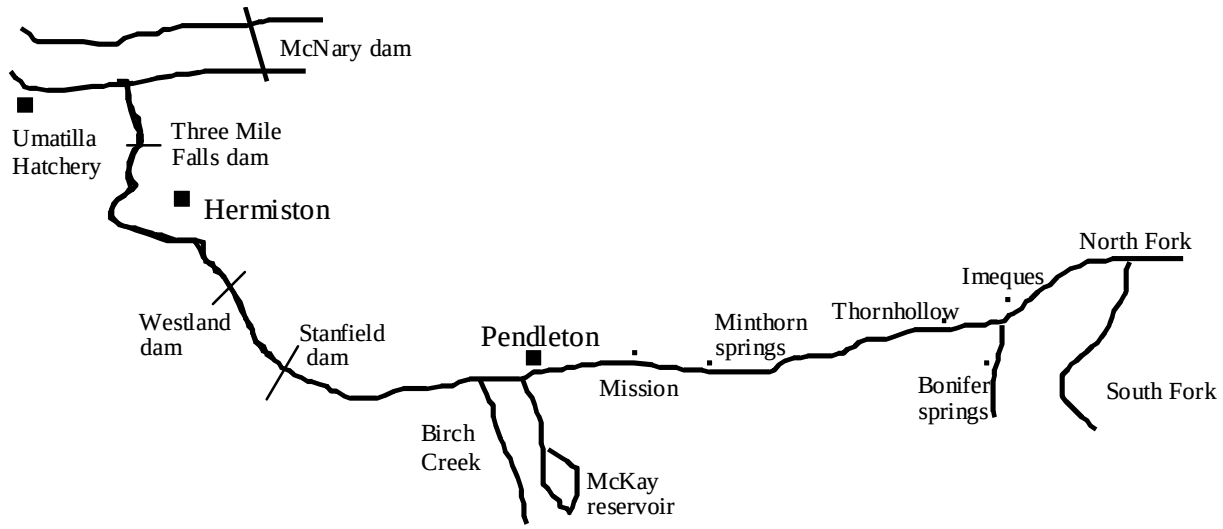

Figure 1. Map of the Umatilla River showing locations discussed in text.

FALL CHINOOK SALMON

Overview

Subyearling fall chinook salmon have been reared in MI or OR raceways at UFH and released in the Umatilla River beginning with the 1991 brood (Appendix Table 2). Adult return data is needed to complete the evaluation of rearing in MI and OR raceways (1991-95 broods). The 1996 brood was reared at different densities in Michigan raceways to evaluate rearing success, juvenile performance, and SAR. Yearlings have also been reared at UFH, BFH, and Willard Fish Hatchery (WFH) and released in the Umatilla River (Appendix Table 3) as additional production and an alternative release strategy. No formal experiments are being conducted with yearlings, but all releases are being monitored and evaluated. All studies are still in progress.

Methods

Subyearlings

Juvenile Rearing and Survival Studies: Methods to monitor water quality and juvenile rearing at UFH were described in 1992-97 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998, Hayes et al. 1999). Most methods used in rearing and survival studies were described in the 1992-97 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998, Hayes et al. 1999). Additions and exceptions are described below.

To estimate the cost of producing fish at UFH we used an estimate of $3.19 per pound from the Integrated Hatchery Operations Team (IHOT) review of hatcheries (1996). Tagging costs were estimated by multiplying the number tagged by $162.30 per thousand for CWT and $115.20 for BWT (personal communication, C. Mallette, ODFW, Clackamas, OR). The final estimated cost per smolt was the sum of hatchery and tagging costs.

In 1998 we used passive integrated transponders (PIT) tags to mark approximately 500 subyearlings from each raceway to monitor juvenile migration and survival. Fish were randomly collected, transported to indoor holding tanks at Irrigon Fish Hatchery (IFH), held off feed for one day, anesthetized, marked, and held for 48 h. Fish were returned to their original raceways at UFH and lost tags in holding tanks were examined. During PIT tagging we determined pre-release smolt quality. We also paint-marked the anal fin of PIT-tagged fish so they could be identified at TMFD by personnel from the Outmigration and Survival study. PIT tag information was submitted and recovery data was obtained from a database maintained by the Pacific States Marine Fisheries Commission (PSMFC).

Adult Survival Studies: Methods to determine SAR were described in the 1992-97 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998, Hayes et al. 1999). Coded-wire tag data was downloaded from (PSMFC) database in January 1999.

Effects of Tagging and Marking: Subyearlings were marked with a combination of fin clips and wire tags to examine the effects of tagging and marking on SAR. Methods were described in the 1992-97 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998, Hayes et al. 1999).

Yearlings

Juvenile Rearing and Survival Studies: Methods to monitor rearing and survival were the same as described for subyearlings with the following exceptions. A subsample of yearlings were collected from the acclimation ponds to identify early maturing fish by examining the gonads. To study juvenile migration and survival, we collected fish from liberation trucks at the acclimation sites and PIT-tagged approximately 250 fish from each raceway containing CWT fish for BFH and WFH releases.

Adult Survival Studies: Methods to determine SAR were the same as described for subyearlings.

Adult Returns to the Umatilla River

Adult return data was collected from fish that were trapped at the eastbank fish ladder at TMFD by the Umatilla River Basin Trap and Haul Program (BPA project number 88-022). We used fork lengths to determine the number of adults, jacks, or subjacks. Sex was evaluated by examining fish for secondary sexual characteristics. Statistics on returning fish were based on CWT data from fish trapped at TMFD, collected in the sport fishery or spawning ground surveys.

We sampled subjacks from the trap at TMFD to determine the gonadosomatic index (GSI). Fish sacrificed for CWT recovery data were measured (FL mm) and weighed (g) for total and gonad weight. The GSI was calculated by dividing gonad weight by total body weight.

Fishery

Except for the following modifications, fall chinook and coho salmon sport fisheries were surveyed as described in the 1993-97 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998, Hayes et al. 1999). The fall chinook and coho salmon sport fishery was open from September 1 to November 30, 1997. Fishing was allowed from Stanfield Dam downstream to the Highway 730 bridge in Umatilla. We did not survey between TMFD and Stanfield Dam because no significant effort was observed in 1997. Anglers were allowed to harvest 2 adult coho salmon per day and 5 coho (16-20 in) or chinook (16-24 in) jacks per day. Adult chinook salmon could be harvested below Highway 730. The percent of the run harvested was calculated by dividing number harvested by the fish count at TMFD plus the estimated harvest below TMFD times 100.

Straying

Fall chinook salmon straying to Lower Granite Dam in the Snake River were estimated by the Washington Department of Fish and Wildlife (personal communication G. Mendel, Washington Department of Fish and Wildlife, Lyons Ferry, WA). Methods used to estimate future strays were described in previous annual reports (Hayes et al. 1996b, Focher et al. 1998, Hayes et al. 1999).

Statistical Analyses

We defined median travel time for PIT-tagged fish as 50% cumulative detections for fish traveling from the release site to John Day (JD) or Bonneville (BN) dams. Differences in the proportion

of PIT-tagged fish collected at JD and BN dams were tested with the binomial test (Sokal and Rohlf 1981). For subyearling fall chinook salmon we compared proportions from fish reared at different densities and between different passes. We used a Z-test (Zar 1974) to test the mean length of PIT-tagged fish detected at JD or BN dams compared to their mean length at tagging. Differences for all tests were considered significant at alpha ≤0.05.

Results

Subyearlings, Rearing in Michigan and Oregon Raceways

Overview: Five broods of subyearling fall chinook salmon (1991-95) were reared in MI and OR raceways at UFH and released in the Umatilla River (Appendix Table 2). The objectives of this study are to compare juvenile rearing and migration performance and SAR between subyearlings produced in MI and OR systems and among groups reared in different MI passes at the design densities.

Juvenile Rearing and Survival Studies: Juvenile rearing and survival data was presented in previous annual reports.

Adult Survival Studies: Estimates of adult return rates and SAR are presented in Table 1. Survival data is complete for the 1991 brood.

Subyearlings, density studies in Michigan Raceways

Overview: One brood of subyearlings (1996) has been reared at three densities in MI raceways. The objectives of this study are to compare juvenile rearing and adult survival for subyearlings reared at densities of 200,000, 300,000, and 400,000 fish per raceway. Therefore, each MI series produces 600,000, 900,000, or 1,200,000 fish, respectively and each raceway represents a unique density-by-pass combination. This experiment will be repeated for four years.

Juvenile Rearing and Survival Studies: Juvenile rearing, release, and survival data are presented in Tables 2-6 and Appendix Tables 1 and 2. Subyearlings (1997 brood) were ponded outside in four OR raceways on February 13, 1998 at 1154-1177 fish/lb. These groups were split into nine MI raceways on March 24, 1998 and transferred to acclimation ponds on 9 and 10 May, 1998. All baffles remained in place during rearing in MI raceways and each series averaged 950 fish per gallon per minute (gpm) and the mean numbers of fish per raceway were 211,526, 308,855, and 407,367 in low, medium, and high density raceways. Mean food conversion ratios after final splits into MI raceways were 0.89 (200K), 0.91 (300K), and 0.79 (400K). Mean food conversion for all raceways combined was 0.86 We estimated a production cost $0.17 per fish.

Smolt data at pre-release and release for the 1997 brood is presented in Tables 5-6. Most subyearlings (86.1-99.5%) were intermediate smolts. Smolts and parr ranged from 0.0-8.5% and 0.0-10.9%, respectively. Little erosion of the dorsal, caudal, or paired fins was observed. Fish with split caudal fins ranged from 3-21% and fish with split dorsal fins ranged from 0-4%.

Tagging, production release and recovery data of PIT-tagged fish is presented in Tables 7-8 and Appendix Table 2. Fish were CWT marked and right ventral clipped from early April to early May.

Coded-wire tag retention ranged from 97.1-100.0% and those recognizably right ventral clipped was 98-100%.

Subyearlings were released from the acclimation ponds on May 28 and June 1. PIT-tagged juveniles were captured at JD dam from June 9 to July 14 and at BN dam fish from June 7 to July 10. No significant differences were observed in the survival rates of PIT-tagged fish reared in low, medium, and high density raceways or between different passes. We found that detection rates were 4%, 6%, and 9% for fish that measured 60-70 mm, 70-80 mm and 80-90 mm (FL) at tagging, respectively.

Adult survival Studies: The first adult returns are expected in 1999.

Effects of Tagging and Marking:

We examined 26 adults for body tags in fall 1997. Final counts for all mark and tag groups after corrections for false positive readings appear in Table 9.

Yearlings

Overview: Two brood years (1994-95) of yearlings have been reared in MI and OR raceways at UFH and released in the Umatilla River. The rearing goal at UFH is to produce smolts that are approximately 8-10 fish per pound at release. Four broods have been reared at BFH (1990-94) and one at WFH (1995). Yearlings from the 1996 brood were reared at BFH and WFH and released in the Umatilla River in 1998.

The objectives of this study are to monitor juvenile rearing and survival and SAR for yearlings produced at UFH, BFH, and WFH. Because the best rearing strategy for fall chinook salmon is unknown, we will compare SAR of yearling and subyearling releases from all hatcheries. Yearling production at UFH may continue when space is available; however, propagation of spring chinook salmon is a priority. Adult return data of fish reared at UFH will be complete by 2002.

Umatilla Hatchery

Juvenile Rearing and Survival Studies: No 1996 brood yearlings were reared at UFH in 1997-98.

Adult Survival Studies: Adult recovery data from previous CWT releases is presented in Table 14. All data is incomplete.

Willard Hatchery

Juvenile Rearing and Survival Studies: Juvenile rearing, release, and survival data for the 1996 brood is presented in Tables 10-13 and Appendix Tables 1 and 3. WFH received 246,744 fingerlings (Umatilla strain, 1996 brood) at 55 fish/lb from UFH on May 8, 1997. These fish were transferred to the Thornhollow acclimation pond and we evaluated smolt condition on 17 March 1998. The percentages of smolts, intermediate smolts, and parr were 99.5%, 0.5%, and 0.0%, respectively. Yearlings were 16.8% descaled, 73.5% partially descaled, and 9.7% with no scale damage. We randomly sampled 20 WFH and

BFH fish from two acclimation ponds, but found no sexually mature fish. Fin condition was generally good and only 7% and 2% of fish had split caudal or dorsal fins. Tag retention of CWT and BWT fish ranged from 98.0-99.7% and 99.8%.

Yearlings were released on April 17, 1998. PIT-tagged fish were captured at JD dam fish from April 29 to May 21 and at BN dam from May 2 to May 28. Mean fork lengths of fish when PIT-tagged (158.4 mm) were not significantly different from fish detected at JD and BN dams (159.2 mm).

Adult Survival Studies: Estimates of adult survival are not yet available

Bonneville Hatchery

Juvenile Rearing and Survival Studies: Juvenile rearing, release, and survival data for the 1996 brood is presented in Tables 11-13. and Appendix Tables 1 and 3**.** Bonneville Hatchery incubated 291,569 fertilized eggs from Bonneville stock and moved fish to outside ponds from February 11-26, 1997. Fish were transferred to the Thornhollow acclimation pond and examined for smolt condition on February 24, 1998. The percentage of smolts, intermediate smolts, and parr was 79.7%, 19.3%, and 1.0%, respectively. Yearlings were 1.0% descaled, 55.3% partially descaled, and 43.7% with no scale damage. Fin condition was generally good, but 4.4% and 0.0% had split caudal or split dorsal fins. Fish were tagged in December 1998 and CWT and BWT retention was 99.7% and 99.3%.

Yearlings were released on March 13, 1998. PIT-tagged fish were captured at JD dam from April 26 to May 12 and at BN dam fish from April 25 to May 7. Mean fork lengths of fish when PIT-tagged (143.8 mm) were not significantly different from fish detected at JD and BN dams (146.8 mm).

Adult Survival Studies: Recovery data from previous releases of CWT fish are presented in Table 14.

Adult Returns to the Umatilla River

A total of 750 fall chinook salmon returned to TMFD in 1997 (Table 15 and Appendix Table 8). Vital statistics on returns and run timing appear in Tables 15-16 and Figure 2. Fish were trapped from 5 September to December 5, 1997. Subjacks (12) peaked on October 20 and November 11, while jack (14) and adult (32) returns peaked on November 3 and 1, respectively. Median dates were October 8, 11, and 17 for subjacks, jacks, and adults, respectively. The run consisted of 160 CWT fish with 35 strays. Strays originated from Lyons Ferry Hatchery (25 jacks and 4 adults), Priest Rapids Hatchery (4 adults), and one subjack of unknown origin. Subyearlings comprised 74% and yearlings 24% of 23 CWTs recovered from age 3+ salmon collected at TMFD. We predict an adult return of 463 (range 335-590) to the Umatilla River in fall 1998 based on run predictions to Bonneville Dam.

We collected 26 subjacks (<450 mm FL) at TMFD to determine age, sex, and GSI. From CWT data we verified that 23 of 26 fish collected were age 2, all were male. These fish were reared at UFH and released in the Umatilla River in spring 1997. The mean length was 371 mm (range 310-440 mm) and mean weight was 526 g (range 260-860 g). Mean gonad weight was 35 g (12-59 g) and mean GSI was 15% (12-24%).

Fishery

Catch and harvest data from the sport fishery for fall chinook and coho salmon is provided in Tables 17-18. Most anglers resided in Umatilla and Morrow counties (97.6%) with 1.5% from other Oregon counties, and 0.9% from out of state. The percentage of anglers using bait/spinning gear was 98.5% and 1.5% used fly fishing equipment. Several CWT fall chinook salmon were observed in the fishery, all were subjacks. No CWT adult fall chinook or coho salmon were sampled in the fishery. One jack coho salmon that was CWT was sampled (code 091753). The expanded harvest estimate for this code was four fish.

Straying

Mendel (1998) estimated that 92 adults and 32 jacks of Umatilla origin arrived at LGD in 1997. The estimated escapement past LGD after marked and tagged fish were removed was 19 adults and 21 jacks. Using CWT data (N=11), percentage of Umatilla strays by brood year was: 10% (1991), 72% (1993), and 18% (1995). No fish from the 1992 or 1994 broods were identified. All Umatilla strays were from subyearling releases except one yearling release (1991 brood). Additional voluntary returns of Umatilla strays to Lyons Ferry Hatchery totaled 17 fish, including eight BWT fish, three CWT fish, one left ventral clip fish, and five fish that were right ventral clipped.

We updated two models to estimate future strays that would escape past LGD. Both ODFW and NMFS models estimated that 21-23 fall chinook salmon of Umatilla origin would stray past LGD in future years (Table 19).

Discussion

Subyearlings, Rearing in Michigan and Oregon Raceways

Preliminary SAR estimates for fish reared in MI and OR raceways and among fish reared in different MI passes are similar. Because SAR has been poor, the number of CWT's recovered may not be adequate (N=35) to perform statistical tests between the MI and OR systems. Therefore, we recommend increasing the number of CWT per group to 60,000 in future studies. Smolt-to-adult survival of the 1991 brood was less than 0.01%. Estimates for the 1992 (0.05%) and 1993 (0.06%) broods indicate improved SAR, but below the master plan goal of 0.30%. Exploitation estimates for these broods were 55-58%, less than master plan predictions (80%). In comparison to fish reared at UFH, SAR of subyearlings released from Priest Rapids Hatchery were 0.03%; 0.22% and 0.62% for the 1991-93 broods, respectively (PSFMC database).

Poor SAR of UFH fish may be related to problems associated with starting a new hatchery, high-density rearing, or passage through the Umatilla and Columbia rivers. Although, juvenile migration data indicated similar SAR for fish reared at different densities, Ewing and Ewing (1995) reported a negative relationship between juvenile rearing density and adult survival. Moreover, Knapp et al. (1998b) reported that survival of juveniles out of the Umatilla River may be as low as 18% in some years.

Until we can accurately determine the number of subyearlings that successfully migrate from the Umatilla River, comparisons of SAR with other hatchery programs will be difficult to evaluate. Fish released from Priest Rapids Hatchery are larger, are released directly into the Columbia River, and

experience different environmental factors during migration than fish released in the Umatilla River. Increased emphasis on PIT tagging and determining the outmigration success of juvenile salmon in the Umatilla River to accurately assess whether poor survival is related to fish quality or environmental conditions in the migration corridor.

Subyearlings, Density Studies in Michigan Raceways

The rearing environment and juvenile fish quality of subyearlings reared at three densities (1996 and 1997) has been similar. Except for oxygen at the head of the raceways, water quality parameters in all MI raceway and pass combinations were similar in 1998. Causes for low oxygen are unknown, but were not observed for the 1996 brood (Hayes et al. 1999). Food conversion by the 1997 brood (0.86) was greater than the 1996 brood (1.61); however, comparisons were confounded because of the extensive tagging that occurs during rearing. Growth and fish condition for the 1996-97 broods were also similar for all raceways despite differences in density and load. Descaling was greater for fish reared at high densities in 1996; however, in 1997 descaling was similar among densities.

Data from PIT-tagged fish collected at JD and BN dams suggested similar migration times and survival rates for subyearling groups reared at three densities. The median travel time to the two dams (19-21d and 20-21d) was greater than observed in recent years from branded or paint-marked fish when travel times averaged less than 15 d (Focher et al. 1998, Hayes et al. 1999) and may suggest a possible PIT-tag effect. Detection at JD dam averaged 5.1-5.8% for all rearing groups but was greater for fish that were larger when originally tagged. The relationship between percent detection and fish passing the dam is unclear because guidance efficiency is unknown. Low recovery may be caused by poor juvenile survival, low guidance efficiency, or fish passing the dams through spill or turbines. Detection of PIT-tagged subyearlings at McNary Dam from fish marked and released at Ringold Hatchery, Priest Rapids Hatchery, and the Hanford Reach (wild fish) of the Columbia River in 1998 were 41%, 13%, and, 25%, respectively (personal communication, P. Hofarth, Washington Department of Fish and Wildlife, Olympia, WA). Data for hatchery fish from these groups also suggests greater survival for fish that were larger at tagging. Releases of PIT-tagged fish in the Umatilla River by ODFW and at McNary Dam by United States Geological Survey (USGS) in 1999 (personal communication, W. Muir, USGS) will help evaluate juvenile migration success through the JD pool. We recommend pilot studies be conducted with PIT-tagged fish that examine increasing the size at release and releasing fish at alternate sites. These studies may guide future experiments.

Smolt-to-adult survival data for the rearing density study is not yet available. However, rearing efficiency will be greatly increased if the SAR of high density groups are comparable to low and medium density groups. A high density raceway contains 33% more fish (400,000) than the standard MI raceway (300,000 fish) and a SAR of 0.30% would produce 300 more adults; therefore, total production could be increased without increasing the water supply. Final conclusions about the effects of rearing at different densities will be determined as CWT data is collected.

Effects of Tagging and Marking:

The study to examine the effects of tagging and marking on survival of subyearlings is complete. Fish from the 1990-92 broods were examined for body tags through 1997. No fish from the study are expected to return to TMFD in 1998. The study goals were hindered by poor experimental design, low adult recovery rates to TMFD, and problems associated with tag detection. Replicate groups of fish marked within one year by body tagging or removing the left ventral fin-clips could not be identified as

returning adults; therefore, the power of replication was lost. Small sample sizes because of poor adult return rates to TMFD precluded statistical analysis. Tag detection was unreliable in many years because the more sensitive "tube" detector was not available. When available, the high sensitivity of the tube detector may have caused us to overestimate the number of body-tagged fish. A correction factor rectified this problem.

Survival of 1990 brood to TMFD was similar for all groups and ranged from 0.022-0.044%. Fish from this brood were tagged with an extra fin clip or body tag but suggest no negative effect.

Statistical analysis of the returns from the 1991 and 1992 broods was not conducted because of small sample sizes. Generally, for both broods the survival rates of fish marked only once (LV or BT) were equal to or more than fish marked twice (BT+LV or AD+CWT). Moreover, the survival pattern was similar in each year. Greatest survival was found for fish marked BT only, followed by LV, AD+CWT or BT+LV.

To complete the goals, this study would need to be redesigned and conducted for several more years. Because body tags were costly, no further study is warranted or suggested at this time.

Yearlings

The 48 h mortality after PIT tagging suggested the health of WFH fish was poor compared to BFH fish; however, there were no differences in juvenile migration performance. Survival indices of PIT-tagged yearlings (1996 brood) reared at WFH and BFH and released in the Umatilla River in 1998 were similar (range 6-10%) despite different release dates (BFH-March 13; WFH-April 17) and different release sizes (BFH 42 g; WFH 58 g).

Recent CWT data suggests poor SAR for yearlings released in the Umatilla River. Expanded counts for the 1990 brood were only 5 fish for each CWT code. Incomplete recovery data from the 1991-93 broods suggests greater survival, but the 0.75% return goal will not be reached. Survival of LFH yearlings (1990-93 broods) released in the Snake River were 0.07%, 0.16%, 0.42%, and 0.47% compared to 0.00%, 0.03%, 0.11%, and 0.02% for yearlings released in the Umatilla River. Lyons Ferry yearlings were released in mid-April at 8-11 fish/lb compared to mid-March releases at 8-10 fish/lb for the Umatilla. Coupled with the survival data of Umatilla subyearlings compared to other hatcheries, this data may indicate that environmental factors during migration and not smolt quality are responsible for the poor survival of fall chinook salmon released in the Umatilla River.

We previously speculated that if there was a positive relationship between survival of subjacks and SAR, fish reared at BFH should exceed the survival of fish reared at UFH (Hayes et al. 1999). Returns of age 2 chinook in 1996 averaged 31 per code for fish reared at BFH compared to 5 per code for fish reared at UFH. However, no analysis could be made because few age 3 fish were recovered in 1997.

We found rapid growth for subjacks that returned to TMFD in 1997. Mean lengths and weights at release were 173 mm FL and 59 g in March 1997. When collected in fall 1997 the mean length had increased to 373 mm (139%) and mean weight increased to 526 g (791%). Whether these fish migrate to saltwater before returning to the Umatilla River or remain in freshwater before returning is unknown. Pattern analysis of scales or otoliths collected from returning subjacks and adults will help determine the migration of these fish.

Subjacks continued to contribute to the run and represent lost adult production. Size-at-release or growth rates may influence early age at maturation. In 1997 we released approximately 127,000 CWT

yearlings (1995 brood) reared at UFH and 60,000 CWT fish from WFH that averaged 7.9 fish/lb and 13.6 fish/lb, respectively. However, 100% of 91 CWT's recovered from subjacks in 1997 were from fish reared at UFH. Data to determine losses of smolts to this life-history strategy should be considered.

Adult Returns to the Umatilla River

Based on numbers released and expected return rates of subyearlings (2.7 million and 0.30%) and yearlings (225,000 and 0.75%), nearly 10,000 fish should annually return to the Umatilla River (CTUIR and ODFW 1990). Adult counts at TMFD in 1997 were 354 fish and have averaged 335 fish since 1985. Historic data suggests total survival (ocean and freshwater) as great as 0.80% for subyearlings and 3.30% for yearlings in some years (Rowan 1998). However, because of exploitation, higher total survival has never translated to large adult returns to the Umatilla River. Recent exploitation (>50%) coupled with poor ocean conditions suggest that adult returns to the Umatilla River will continue to be lower than expected. Moreover, adult survival may be related to poor survival of juveniles or smolt size and quality (see above discussion).

Adult return predictions to the Umatilla River using jack to adult ratios have proved unreliable. Current predictions are based on pre-season forecasts of Upriver Brights to Bonneville Dam and reliability of pre-season forecasts will be determined by monitoring future returns.

Data from CWT fish recovered at TMFD suggests differences in age at return for fish released as subyearlings and yearlings. As in past years, the majority (91/100) of age 2 fish returning to the Umatilla River originated from yearling releases. Fork lengths of age 2 fish from subyearling releases averaged 53 mm greater than yearling releases in 1997. Too few CWT fish were collected to determine a relationship between release strategy and run timing. Median return date for all ages of salmon in 1997 were similar to 1996 observations. Respective dates for 1996 and 1997 were: subjacks – October 8 and 14; jacks – October 11 and 15, and adults – October 17 and 19. Broodstock management may be improved if the median return date is similar from year to year.

Fishery

Fishing effort for fall chinook and coho salmon in 1997 (2,742 h) was within the range previously reported. Catch rates (0.09 and 0.05 fish/h) for jack and adult chinook and coho salmon were as great or greater than in any previous year. Total harvest for chinook (192) and coho salmon (171) was also the greatest we have observed. Harvest estimates below TMFD plus run counts at TMFD were 943 and 974 for chinook and coho salmon. Therefore, harvest represented 20% (192/943) and 18% (171/974) of the 1997 fall chinook and coho salmon runs (subjack, jacks and adults). Although some anglers during the early season fishery (September-November) target steelhead, chinook and coho salmon also attract many anglers. The increased harvest may indicate that anglers are learning how to target this fishery.

Straying

Fall chinook salmon from Umatilla River releases continue to stray into the Snake River. Counts of salmon (all stocks) at LGD in 1997 were 1,451 adult and 504 jacks (Mendel 1998) and Umatilla River releases contributed 14% of the adult hatchery run. However, removal of wire-tagged adults reduced stray escapement to 40 fish. Because most strays were identified by the wire tag, we recommend eliminating the right-ventral fin clip as a production mark. Elimination of the ventral clip would reduce

marking costs, the stress associated with handling and tagging, and may increase fish size at release and improve fish health.

Straying remains a concern and constitutes a loss of escapement to the Umatilla River. Returns of fall chinook salmon at TMFD in 1997 were 750 fish. Of the 750, 78% (582) were Umatilla origin. In comparison, 124 salmon (>12 in) of Umatilla origin were collected in the Snake River. These strays would have increased the Umatilla run by 21%. Methods to reduce straying should be investigated. If straying could be reduced, the need to mark all Umatilla stock would be eliminated and production costs would decrease substantially.

Straying may be reduced by longer acclimation, increasing attraction flows at the mouth of the Umatilla River, or developing an endemic broodstock. Because of poor adult survival and the large egg-take needed to support the subyearling program, eggs continue to be collected at Priest Rapids Hatchery and development of a Umatilla stock is not expected in the near future. All fish have been acclimated since 1995 (1994 brood) and Umatilla River flows in September have been increased, but fish continue to stray. Preliminary analysis indicates that adults from yearling releases return to the Umatilla River at the same time as adults from subyearling releases yet stray less. Therefore, flow alone may not be a problem and subyearlings probably stray for other reasons. It is possible that subyearlings are not acclimated at the right time to imprint on the Umatilla River. We suggest monitoring physiological smolt development as a size-at-release experiment (see above) to evaluate when imprinting may occur. To improve adult attraction to the Umatilla River, use of salmon as a pheromone attractant may be considered in the future. This strategy has been used with some success in the Elk River, Oregon (, personal communication G. Susac, ODFW, Portland, OR) and may have potential for improving homing and decreasing straying of Umatilla releases.

Table 1. Exploitation and survival of subyearling fall chinook salmon that were coded-wire-tagged (CWT) and released in the Umatilla River, 1991-93 broods. Recoveries include age 3 and older fish and are complete for the 1991-92 broods, other brood data is incomplete. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in January 1999.

Brood year, CWT code	Raceway	N[a]	Total exploitation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of jacks and adults recovered
1991						
071433	M2A	0	0.0	0.00	0.00	0
071434	M3A	0	0.0	0.00	0.00	0
071435	M2B	0	0.0	0.00	0.00	0
071436	M3B	0	0.0	0.00	0.00	0
071437	M2C	1	0.0	<0.01	<0.01	7
071438	M3C	0	0.0	0.00	0.00	0
Subtotal/Average		1	0.0	<0.01	<.0.01	7
071430	O2A	3	66.7	<0.01	0.01	26
071429	O3A	1	0.0	<0.01	<0.01	9
071432	O2B	0	0.0	0.00	0.00	0
071431	O3B	0	0.0	0.00	0.00	0
Subtotal/Average		4	0.0	<0.01	<0.01	35
Total/Average		5	0.0	<0.01	<0.01	42
1992						
076330	M2A	12	50.0	0.02	0.04	121
076331	M3A	17	58.8	0.02	0.06	162
070127	M2B	19	63.2	0.03	0.07	189
076333	M3B	19	47.3	0.02	0.06	175
076334	M2C	8	37.5	0.02	0.03	75
076332	M3C	17	76.5	0.01	0.06	160
Subtotal/Average		92	55.6	0.02	0.05	883
070126	O2A	21	57.1	0.02	0.07	190
070125	O3A	13	61.5	0.01	0.04	121
076329	O2B	21	66.7	0.01	0.07	139
076335	O3B	15	33.3	0.03	0.05	102
Subtotal/Average		70	54.7	0.02	0.06	552
Total/Average		162	55.1	0.02	0.06	1,436

[a] *Expanded CWT recoveries.*

Table 1 (continued)

Brood year, CWT code	Raceway	N[a]	Total exploi-tation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of jacks and adults recovered
1993						
070663	M2A	14	85.7	0.01	0.05	145
070719	M3A	15	66.7	0.02	0.05	155
070720	M2B	27	81.5	0.01	0.09	278
070723	M3B	9	55.6	0.01	0.03	96
070722	M2C	21	52.4	0.03	0.07	206
070721	M3C	10	30.0	0.02	0.04	108
Subtotal/Average		96	62.0	0.02	0.05	989
070662	O2A	25	80.0	0.01	0.08	224
070718	O3A	2	00.0	0.01	0.01	18
070716	O2B	18	66.7	0.02	0.06	113
070717	O3B	27	70.4	0.02	0.08	158
Subtotal/Average		72	54.3	0.02	0.06	513
Total/Average		168	58.1	0.02	0.06	1,502
1994						
071019	M2A	0	00.0	0.00	0.00	0
071017	M3A	0	00.0	0.00	0.00	0
071022	M2B	0	00.0	0.00	0.00	0
071020	M3B	0	00.0	0.00	0.00	0
071025	M2C	0	00.0	0.00	0.00	0
071023	M3C	0	00.0	0.00	0.00	0
Subtotal/Average		0	00.0	0.00	0.00	0
071026	O2A	0	00.0	0.00	0.00	0
071018	O3A	1	00.0	<0.01	<0.01	8
071024	O2B	0	00.0	0.00	0.00	0
071021	O3B	0	00.0	0.00	0.00	0
Subtotal/Average		1	00.0	<0.01	<0.01	0
Total/Average		1	00.0	<0.01	<0.01	0

Table 2. Egg-take and survival of subyearling fall chinook salmon reared at Umatilla Hatchery, 1996-97 broods.

Egg source	Brood year	Number of eggs taken or received	Egg-to-fry survival (%)	Egg-to-smolt survival[a] (%)
Priest Rapids	1996	3,358,649	73.2	
Umatilla River	1996	778,028	63.6	
Total		4,136,677	71.3	62.4
Priest Rapids	1997	4,427,536	71.3	67.5

[a] *Survival estimate is based on green egg-to-smolt stage.*

Table 3. Rearing conditions immediately before transfer for subyearling fall chinook salmon at three densities in Michigan series at Umatilla Hatchery in 1998, 1997 brood.

Brood year	Series	Target number per raceway	Maximum density (lb/ft^3)	Maximum loading (lb/gal/min)[a]	Number reared per gpm
1996	M4	200,000	1.0-1.1	2.3-2.7	617
1996	M1	300,000	1.6-1.7	3.7-3.9	940
1996	M2	400,000	1.7-2.1	4.0-4.9	1,159
1997	M2	200,000	1.2-1.4	2.9-3.2	668
1997	M3	300,000	1.6-1.8	3.9-4.3	975
1997	M4	400,000	2.1-2.3	5.0-5.3	1,286

[a] *Flow in the Michigan raceways is 950 gpm*

Table 4. Water quality in three Michigan raceways used to rear subyearling fall chinook salmon at three densities in 1998, 1997 brood. Values are means (N/A, no data available).

	Density/Raceway								
	200K			300K			400K		
Parameter measured	M2A	M2B	M2C	M3A	M3B	M3C	M4A	M4B	M4C
Temperature head (d-C)	11.4	11.3	11.5	11.4	11.4	11.6	11.6	11.7	11.8
Temperature tail (d-C)	11.4	11.4	11.5	11.4	11.5	11.6	11.7	11.7	12.0
pH head	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.6	7.5
pH tail	7.5	7.5	7.6	7.6	7.6	7.6	7.5	7.5	7.5
Oxygen head (ppm)	12.1	11.2	10.9	12.2	10.7	11.1	12.2	9.6	8.8
Oxygen tail (ppm)	10.3	9.0	8.4	9.5	8.7	8.7	8.6	7.3	7.1
Nitrogen head (mmHg)	578	577	584	498	595	583	568	597	601
Nitrogen tail (mmHg)	588	596	600	588	588	595	582	601	611
Total pressure-head (mmHg)	751	739	740	753	749	745	747	738	739
Total pressure-tail (mmHg)	732	725	721	725	713	722	707	707	716
Unionized ammonia (ug/l)	0.41	1.34	2.59	0.57	2.07	4.21	N/A	N/A	N/A
Alkalinity (mg/l CaCO3)	134	133	133	133	135	134	139	138	139

Table 5. Mean length, weight, and condition factor for subyearling fall chinook salmon reared at three densities in Michigan raceways at Umatilla Hatchery and in Thornhollow or Imeques acclimation ponds in 1998, 1997 brood.

Sample Density	Pass or pond	Length(mm) N	Length(mm) Mean(SE)	Weight(g) N	Weight(g) Mean(SE)	Condition Factor N	Condition Factor Mean(SE)
April 1:							
200,000	A	125	60.6(0.3)	51	2.5(0.1)	51	1.12(0.01)
	B	99	60.7(0.4)	99	2.8(0.1)	99	1.23(0.02)
	C	122	60.6(0.3)	78	2.8(0.1)	78	1.27(0.01)
April 1:							
300,000	A	105	61.2(0.3)	69	2.7(0.1)	69	1.19(0.02)
	B	60	61.2(0.4)	60	3.0(0.1)	60	1.30(0.02)
	C	103	60.1(0.4)	66	2.4(0.0)	66	1.09(0.01)
April 1:							
400,000	A	112	59.6(0.3)	55	2.2(0.1)	55	1.03(0.01)
	B	111	58.7(0.3)	63	2.3(0.1)	63	1.09(0.02)
	C	105	59.7(0.4)	80	2.4(0.0)	80	1.12(0.01)
Pre-release:							
200,000	A	231	77.9(0.4)	106	4.9(0.1)	105	1.03(0.01)
May 4-6	B	198	77.3(0.4)	100	4.6(0.1)	99	0.97(0.01)
	C	201	78.5(0.4)	130	5.4(0.1)	129	1.07(0.01)
Pre-release:							
300,000	A	206	77.3(0.4)	123	4.8(0.1)	123	1.08(0.01)
May 4-6	B	208	79.3(0.5)	137	4.4(0.1)	137	0.89(0.01)
	C	202	77.6(0.4)	103	4.7(0.1)	103	0.97(0.01)
Pre-release							
400,000	A	209	78.0(0.9)	102	4.5(0.1)	102	1.00(0.01)
May 4-6	B	205	76.6(0.4)	112	3.7(0.1)	112	0.82(0.01)
	C	214	75.3(0.5)	115	4.4(0.1)	115	1.00(0.01)
Release Thornhollow							
May 28	1	316	85.3 (0.3)	216	6.9(0.1)	216	1.12 (0.01)
	2	332	85.2 (0.4)	222	7.1(0.1)	222	1.15 (0.02)
Release Imeques							
June 1	1	318	84.5 (0.4)	207	6.5(0.1)	207	1.07 (0.00)
	2	356	86.0 (0.4)	245	6.8(0.1)	245	1.07 (0.00)
	3	353	86.1 (0.3)	233	6.8(0.1)	233	1.06 (0.00)
	4	307	85.0 (0.4)	195	6.7(0.1)	195	1.08 (0.01)

Table 6. Mean proportion of descaled, partially descaled, and undamaged subyearling fall chinook salmon reared at three densities in Michigan raceways at Umatilla Hatchery in 1998, 1997 brood.

Raceway	Density	Descaled[a]	Partially descaled[b]	Undamaged[c]
M2A	200,000	0.4	4.0	95.5
M2B		0.5	7.0	92.5
M2C		0.0	3.5	96.5
M3A	300,000	0.0	4.9	95.1
M3B		0.0	3.0	97.0
M3C		0.0	4.9	95.1
M4A	400,000	0.0	11.1	89.9
M4B		0.0	0.0	100.0
M4C		0.0	0.5	99.5

[a] *More than 0.20 descaling on either side of the fish.*
[b] *Descaling = 0.03 to 0.20 on either side of the fish.*
[c] *Less than 0.03 descaling on either side of the fish.*

Table 7. Tag and mark information for subyearling fall chinook salmon reared at Umatilla Hatchery and released in the Umatilla River in 1998, 1997 brood (CWT = coded wire tag, AD = adipose fin, RV = right ventral fin).

Race-way	Release date[a]	CWT code	Number CWT[b]	Fin clip	Number PIT tagged fish released[c]	PIT tags extruded after 48 h (%)	PIT-tag mortalities after 48 h (%)	Total number released
M2A	May 28	092404	33,286	ADRV	520	0.0	1.0	214,521
M2B	June 1	092407	32,661	ADRV	505	0.0	0.0	202,816
M2C	June 1	092410	31,820	ADRV	508	0.0	0.2	215,643
M3A	May 28	092403	30,808	ADRV	493	0.0	4.3	305,038
M3B	June 1	092406	30,558	ADRV	510	0.0	0.2	317,296
M3C	June 1	092409	32,219	ADRV	509	0.0	0.0	302,336
M4A	May 28	092402	30,654	ADRV	504	0.0	0.4	400,614
M4B	June 1	092405	30,533	ADRV	507	0.0	0.4	413,832
M4C	June 1	092408	32,322	ADRV	508	0.0	0.0	405,346

[a] *Number recognizably CWT and released. All CWT fish were adipose fin clipped. All fish were right ventral fin clipped and all non-CWT fish were marked with a blank-wire tag.*
[b] *PIT-tag tagging files for raceways WAC98126.M2A, WAC98124.M2B, WAC98124.M2C, WAC98126.M3A, WAC98125.M3B, WAC98125.M3C, WAC98126.M4A, WAC98125.M4B, WAC98125.M4C.*
[c] *Mortality in pond M3A was caused primarily by an overdose of anesthetic.*

Table 8. Number and percent detected, median travel time, and median detection date at John Day and Bonneville dams for subyearling fall chinook salmon reared at three densities, PIT tagged, and released in the Umatilla River, spring 1998.

		John Day			Bonneville		
Raceway	Density	Percent detected (number)	Median travel time (d)	Median detection date	Percent detected (number)	Median travel time (d)	Median detection date
Released on May 28, 1998							
M2A	200,000	6.5(34)	18	June 15	2.9(15)	18	June 15
M3A	300,000	4.9(24)	19	June 16	3.4(17)	19	June 16
M4A	400,000	4.2(21)	21	June 18	1.2(6)	19	June 16
Released on June 1, 1998							
M2B	200,000	5.1(26)	19	June 16	2.2(11)	21	June 18
M3B	300,000	5.3(27)	22	June 19	3.5(18)	21	June 18
M4B	400,000	6.1(31)	27	June 24	2.2 (11)	24	June 21
M2C	200,000	5.7(29)	23	June 20	1.4(7)	25	June 22
M3C	300,000	5.5(28)	24	June 21	2.6(13)	24	June 21
M4C	400,000	5.1(26)	24	June 21	3.1(16)	19	June 16
Summarized by rearing density group[a]							
M2A-C	200,000	5.8(89)	15	June 16	2.1(33)	17	June 18
M3A-C	300,000	5.2(79)	17	June 18	3.2(48)	17	June 18
M4A-C	400,000	5.1(78)	20	June 21	2.2(33)	15	June 16

[a] *Travel times were based on the June 1 release date*

Table 9. Recovery of marked adult fall chinook salmon that returned to Three Mile Falls Dam in the Umatilla River from 1992-97 (AD = adipose fin clip, BT = body tag, CWT = coded-wire-tag, LV = left ventral fin clip, and RV = right ventral fin clip).

Brood year[a]	Mark	Number released	CWT code	Number Recovered 1992	1993	1994	1995	1996	1997	Total(%)
1990	BT	147,586	-	0	2	13	15	2	0	32(0.022)
	AD+CWT	51,814	075450	1	2	15	5	0	0	23(0.044)
		52,444	075451	2	3	6	2	0	0	13(0.025)
	AD+CWT+RV	52,252	075225	0	1	10	4	0	0	15(0.029)
		51,728	075226	0	2	2	3	0	0	7(0.014)
	AD+CWT+BT	48,266	075328	3	3	6	4	0	0	16(0.033)
		48,481	075499	2	1	12	4	0	0	19(0.039)
		48,301	070016	0	1	5	4	1	0	11(0.023)
1991	LV	69,816	-	-	1	4	1	3	0	9(0.006)
		74,408	-	-						
	BT+LV	67,144	-	-	0	0	0	1	0	1(0.001)
		65,749	-	-						
	BT	65,184	-	-	2	5	1	2	0	10(0.015)
		70,435	-	-						
	AD+CWT+RV	32,278	071430	-	-	0	0	1	0	1(0.003)
		31,892	071429	-	-	1	0	0	0	1(0.003)
1992	LV	61,801	-	-	-	12	9	14	5	40(0.031)
		66,204	-	-	-					
	BT+LV	68,644	-	-	-	7	7	6	0	20(0.029)
		70,442	-	-	-					
	BT	69,225	-	-	-	7	12	6	3	28(0.040)
		69,518	-	-	-					
	AD+CWT+RV	29,594	070126	-	-	0	5	1	0	6(0.020)
		29,360	070125	-	-	2	4	3	0	9(0.031)

[a] *Fish not CWT were assigned to a brood year by length frequency data and CWT percents.*

Table 10. Rearing conditions immediately before transfer for yearling fall chinook salmon in Michigan and Oregon raceways at Umatilla, Bonneville, and Willard hatcheries, 1994-96 broods.

Brood year	System	Maximum density (lb/ft^3)	Maximum loading (lb/gal/min)	Number reared per gpm
		Umatilla Hatchery		
1994	Oregon	3.9-4.0	9.5	151
1995	Michigan	2.6-3.0	6.2-7.1	165
1995	Oregon	1.0-1.1	4.9-5.3	82
		Bonneville Hatchery		
1994	Oregon	0.8-1.0	6.0-7.0	58
1996	Oregon	0.4-0.8	2.9-5.8	53
		Willard Hatchery		
1995	Oregon	1.4-2.6	4.1-7.5	69
1996	Oregon	1.1-2.2	3.3-6.4	40

Table 11. Mean length, weight, and condition factor for yearling fall chinook salmon reared at Bonneville and Willard hatcheries and released in the Umatilla River in 1998, 1996 brood.

Sample/	Length(mm)		Weight(g)		Condition Factor	
Raceway	N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
			Bonneville Hatchery			
Pre-release: February 24						
A11	209	144.0(1.0)	98	35.6(1.1)	98	1.16(0.01)
Release Thornhollow: March 13						
TH1	328	146.9(0.8)	211	39.6(0.8)	211	1.20(0.01)
TH2	306	152.0(0.9)	202	44.2(1.0)	202	1.21(0.01)
			Willard Hatchery			
Pre-release: March 17						
41	302	158.2(0.6)	108	42.8(0.9)	108	1.04(0.01)
42	304	158.6(0.6)	105	43.9(0.9)	104	1.06(0.01)
Release Thornhollow: April 17						
TH1	243	175.5(0.9)	205	61.9(1.0)	205	1.11(0.01)
TH2	314	169.6(0.8)	196	54.9(1.0)	196	1.10(0.01)

Table 12. Tag and mark information for yearling fall chinook salmon reared at Bonneville and Willard hatcheries and released in the Umatilla River in 1998, 1996 brood (CWT = coded-wire-tag, AD = adipose fin, RV = right ventral fin).

Raceway	Release date[a]	CWT code	Number CWT[b]	Fin clip	Number PIT-tagged fish released[c]	PIT-tags extruded after 48 h (%)	PIT-tag mortalities after 48 h (%)	Total number released
			Bonneville Hatchery					
11	March 13	092037	24,402	ADRV	217	12.6	1.6	256,910
			Willard Hatchery					
41	April 17	071158	21,547	ADRV	210	12.0	3.5	89,106
42	April 17	076127	22,783	ADRV	230	1.2	3.1	89,994

[a] *Number recognizably CWT and released. All CWT fish were adipose fin clipped. All fish were right ventral fin clipped and all non-CWT fish were marked with a blank-wire tag.*
[b] *PIT-tag files for raceways WAC98055.THH (Bonneville), WAC98076.W41, WAC98076.W42.*

Table 13. Number and percent detected, median travel time, and median detection date at John Day and Bonneville dams for yearling fall chinook salmon that were reared at Bonneville (BFH) and Willard (WFH) hatcheries, PIT-tagged and released in the Umatilla River in 1998, 1996 brood.

		John Day			Bonneville		
Raceway(s)	CWT code	Percent detected (number)	Median travel time (d)	Median detection date	Percent detected (number)	Median travel time (d)	Median detection date
		Bonneville Hatchery (Released on March 13, 1998)					
10-16	092037	6.4(14)	50	May 2	3.2(7)	51	May 3
		Willard Hatchery (Released on April 17, 1998					
41	071158	7.1(15)	22	May 9	4.8(10)	18	May 5
42	076127	10.0(23)	21	May 8	3.9(9)	20	May 7
Total		8.6(38)	22	May 9	4.3(19)	19	May 6

Table 14. Exploitation and survival of yearling fall chinook salmon reared at Umatilla, Bonneville, and Willard hatcheries, coded-wire-tagged (CWT), and released in the Umatilla River, 1990-95 broods. Recoveries include age 3 and older fish. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in January 1999.

Brood year, CWT code	Raceway	N[a b]	Total exploi-tation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of jacks and adults recovered
		Umatilla Hatchery				
1994						
071039	M3A	0	0.00	0.00	0.00	0
071040	M3B	1	0.00	<0.01	<0.01	2
071041	M3C	0	0.00	0.00	0.00	0
Total/Average		1	0.00	<0.01	<0.01	2
1995						
091729	O3A	0	0.00	0.00	0.00	0
091748	O3B	0	0.00	0.00	0.00	0
Subtotal/Average		0	0.00	0.00	0.00	0
071358	M1A	0	0.00	0.00	0.00	0
091807	M1B	0	0.00	0.00	0.00	0
071359	M1C	0	0.00	0.00	0.00	0
Subtotal/Average		0	0.00	0.00	0.00	0
Total/Average		0	0.00	0.00	0.00	0
		Bonneville Hatchery				
1990						
075618	A8	0	0.00	0.00	0.00	0
075619	A9	0	0.00	0.00	0.00	0
Total/Average		0	0.00	0.00	0.00	0
1991						
071460	A5	3	33.3	<0.01	0.01	9
071461	A6	9	44.4	0.02	0.04	26
Total/Average		12	38.9	0.01	0.03	34

[a] *Expanded CWT recoveries.*

[b] *Observed recoveries of age two subjacks (<381 mm FL) for each tag code were: 71039 - 2, 071040 - 7, 071041 - 12; 091729 - 13, 091748 - 24, 091358 - 20, 091807 - 22, 091359 - 2, 071460 - 3, 071461 - 3.*

Table 14 (continued)

Brood year, CWT code	Raceway	N[a b]	Total exploi-tation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of jacks and adults recovered
1992						
070252	A5	13	00.0	0.01	0.06	28
070255	A6	41	43.9	0.07	0.17	404
Total/Average		54	22.0	0.04	0.11	432
1993						
070658	A2	10	30.0	0.03	0.04	45
070659	A6	0	0.00	0.00	0.00	0
Total/Average		10	15.0	0.01	0.02	45
1994						
071037	A4	2	0.00	<0.01	<0.01	15
071038	A3	0	0.00	0.00	0.00	0
Total/Average		2	0.00	<0.01	<0.01	15
Willard Hatchery						
1995						
070953		0	0.00	0.00	0.00	0
070954		0	0.00	0.00	0.00	0
Total/Average		0	0.00	0.00	0.00	0

[a] *Expanded CWT recoveries*

[b] *Additional recoveries of age two subjacks (<381 mm FL) for each tag code were:, 070252 - 15, 070255 - 34, 070658 - 47, 070659 - 27, 071037 - 57, 071038 - 23. 070954-1.*

Table 15. Number of fall chinook salmon that returned to the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1995-97.

	Male		Female		Unknown		Total	
Age[a]	Number	%	Number	%	Number	%	Number	%
1995								
Subjack	338	100.0	0	0.0	0	0.0	338	27.5
Jack	286	99.3	2	0.7	0	0.0	288	23.4
Adult	360	59.7	243	40.3	0	0.0	603	49.1
Total	984	80.1	245	19.9	0	0.0	1,229	100.0
1996								
Subjack	606	100.0	0	0.0	0	0.0	606	45.5
Jack	80	100.0	0	0.7	0	0.0	80	6.0
Adult	357	55.3	289	44.7	0	0.0	646	48.5
Total	1,043	78.3	289	21.7	0	0.0	1,332	100.0
1997								
Subjack	189	100.0	0	0.0	0	0.0	189	25.2
Jack	207	100.0	0	0.0	0	0.0	207	27.6
Adult	127	35.9	227	64.1	0	0.0	354	47.2
Total	523	69.7	227	30.3	0	0.0	750	100.0

[a] *Age designation based on fork length: subjacks <381 mm, jacks 382-610 mm, adults >610 mm.*

Table 16. Vital statistics of fall chinook salmon that returned to the east-bank fish ladder, Three Mile Falls Dam, Umatilla River in 1997 by release strategy and hatchery. Data was determined from coded-wire-tag recovery (sex was determined visually, all age 2 fish were assumed to be male).

Hatchery/ Brood year	Age	Number	Sex	Fork length (mm) Mean	Min	Max
			Subyearling			
Umatilla						
1992	5	2	male	1020	985	1055
	5	4	female	847	768	885
1993	4	5	male	799	735	880
	4	7	female	818	775	875
1994	3	1	male	700		
1995	2	9	male	426	385	485
			Yearling			
Umatilla Hatchery						
1994	3	1	male	490		
1995	2	91	male	373	305	460
Bonneville Hatchery						
1992	5	1	male	843		
1993	4	2	male	650	650	650
1994	3	2	male	535	530	540
Lyons Ferry Hatchery						
1992	5	1	male	790		
1993	4	3	male	668	620	720
	4	1	female	695		
1994	3	25	male	515	429	580

Table 17. Estimated catch statistics for fall chinook and coho salmon in the lower Umatilla River from the mouth to Three Mile Falls Dam in 1997. Number caught and number harvested includes ± 95% confidence interval.

				Fall Chinook Salmon					
				Adult Salmon[a]			Jack Salmon		
Month, Day type	Number Days	Sampled Anglers	Hours fished	Number caught	Number harvested[a]	Catch rate fish/h	Number caught	Number harvested	Catch rate (fish/h)
September									
Weekday	5	13	290	0± 0	0± 0	0.00	63± 70	63± 70	0.22
Weekend	5	16	361	0± 0	0± 0	0.00	43± 81	43± 81	0.12
Total	10	29	651	00±00	0± 0	0.00	106±107	106±107	0.16
October									
Weekday	11	93	696	26±20	10±11	0.04	71± 48	36± 28	0.10
Weekend	8	124	518	3 ± 4	1± 3	0.01	45± 22	28± 17	0.09
Total	19	217	1,214	29±20	11±11	0.02	116± 43	64± 43	0.09
November									
Weekday	9	51	348	13±19	0± 0	0.04	00± 00	0± 0	0.00
Weekend	11	137	529	11± 8	0± 0	0.02	13± 6	11± 6	0.02
Total	20	188	877	24±20	0± 0	0.03	13± 6	11± 6	0.02
Grand Total	49	434	2,742	53±29	11±11	0.02	235±120	181±112	0.06

				Coho Salmon					
				Adult Salmon			Jack Salmon		
Month, Day type	Number days	Sampled anglers	Hours fished	Number caught	Number harvested	Catch rate fish/h	Number caught	Number harvested	Catch rate (fish/h)
September									
Weekday	5	13	290	0± 0	0± 0	0.00	73±136	73±136	0.25
Weekend	5	16	361	0± 0	0± 0	0.00	22± 39	22± 39	0.06
Total	10	29	651	0± 0	0± 0	0.00	95±142	95±142	0.14
October									
Weekday	11	93	696	18±20	18±20	0.03	54± 29	30± 21	0.08
Weekend	8	124	518	19±15	19±15	0.04	8± 6	8± 6	0.01
Total	19	217	1,214	37±25	37±25	0.03	62± 30	38± 22	0.04
November									
Weekday	9	51	348	0± 0	0± 0	0.00	0± 0	0± 0	0.00
Weekend	11	137	529	0± 0	0± 0	0.00	1± 1	1± 1	0.00
Total	20	188	877	0± 0	0± 0	0.00	1± 1	1± 1	0.00
Grand Total	49	434	2,742	37±25	37±25	0.02	158±145	134±143	0.03

[a] Harvest of adult fall chinook salmon was legal below Highway 730.

Table 18. Summary of fall chinook and coho salmon catch statistics (jacks and adults), Umatilla mouth to Three Mile Falls Dam, 1992-97.

			Chinook Salmon			Coho Salmon		
Year	Sampled anglers	Hours fished	Number caught	Number harvested	Catch rate (fish/h)	Number caught	Number harvested	Catch rate (fish/h)
1992	562	2,210	148	41	0.12	132	105	0.04
1993	639	1,666	15	9	0.01	53	53	0.02
1994	596	2,898	250	73	0.09	75	33	0.03
1995	517	2,201	120	46	0.03	55	48	0.01
1996	665	3,789	289	177	0.06	95	95	0.01
1997	434	2,742	288	192	0.09	195	171	0.05

Table 19. Number of fall chinook salmon planned for release in the Umatilla River and predicted escapement of stray returning adults above Lower Granite Dam using a model developed by the Oregon Department of Fish and Wildlife and a model developed by the National Marine Fisheries Service.

Oregon Department of Fish and Wildlife model

Group	Juveniles released into the Umatilla River	Strays above Lower Granite Dam		
		Low	Mean	High
Subyearlings	2,682,000	2	19	52
Yearlings	480,000	0	4	15
Total	3,162,000	2	23	67

National Marine Fisheries Service model

	Stray fish to Lower Granite Dam		Strays above Lower Granite Dam			Juveniles released into the Umatilla River	
Return year	Umatilla	Other	Umatilla	Other	Total	Number	Years
1992	41	2	4	2	6	3,450,000	1988-1991
1993	195	10	20	10	30	3,430,000	1989-1992
1994	268	18	27	18	45	3,279,000	1990-1993
1995	285	114	29	114	143	3,201,000	1991-1994
1996	50	213	5	200	205	3,057,821	1992-1995
1997	124	212	40	172	212	3,118,935	1993-1996
Average	161	95	21	86	107	3,256,126	1988-1996

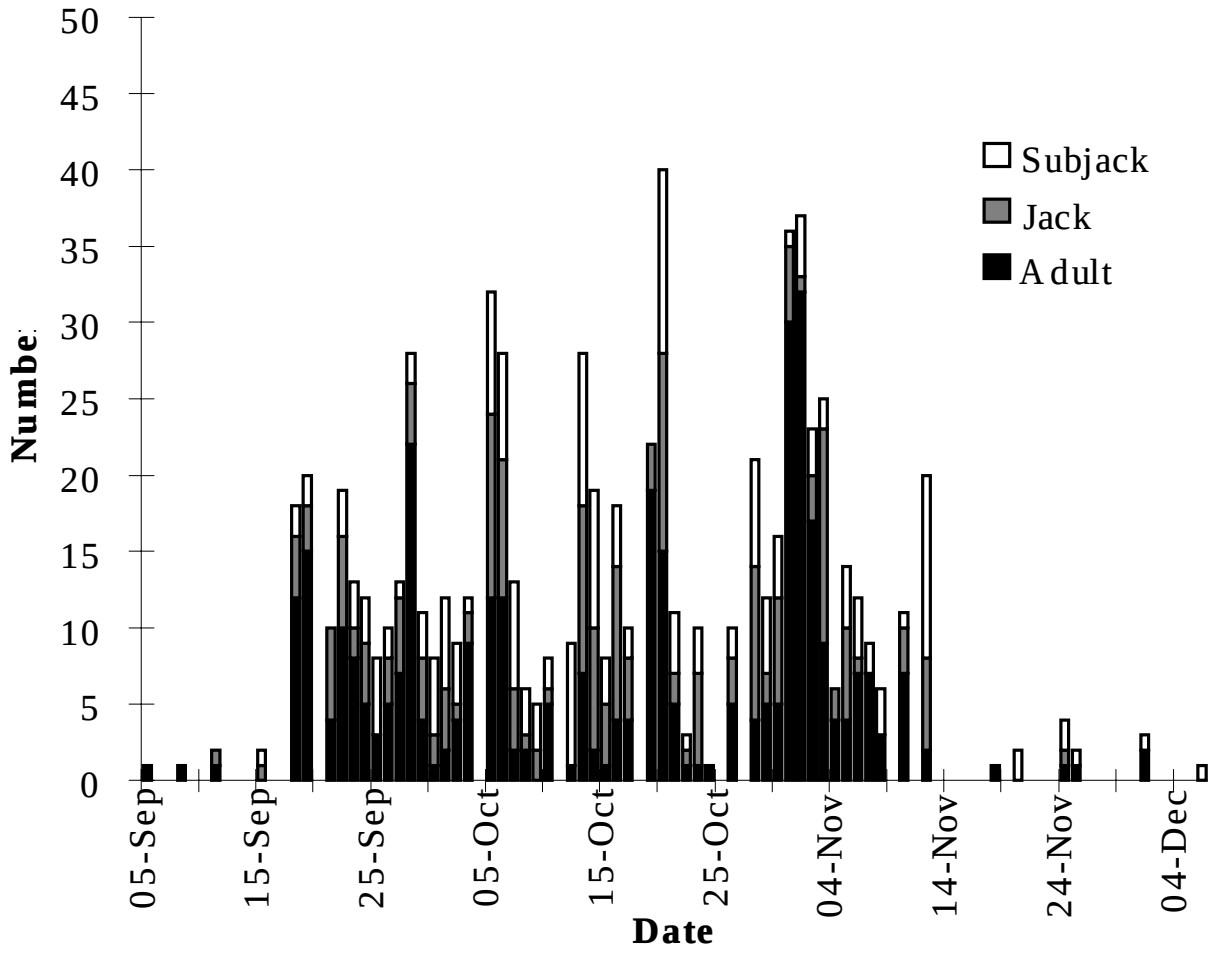

Figure 2. Numbers of subjack, jack, and adult fall chinook salmon counted at the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1997.

SPRING CHINOOK SALMON

Overview

To restore spring chinook salmon to the Umatilla River, three rearing and release strategies have been used at UFH. Five yearling broods (1991-96) were reared at UFH. The yearling release strategy is considered experimental because embryos are chilled to retard size to 10 fish/lb at spring release. Additional yearlings for release in the Umatilla River are also reared at BFH, WFH, and CFH. These groups are used to compare the success of fish produced at UFH. Subyearlings were reared (1991-93 broods) because of the growth potential in warm water. The subyearling strategy has been eliminated because size-at-release goals were not attained and near zero SAR. Fish were also released in the fall (1991-93 broods) because additional rearing space was available and fall releases had shown some success in the Willamette River. Smolt-to-adult survival of the fall release strategy was poor and releases were discontinued; however, this strategy may be resumed depending on space and budget considerations.

Methods

Subyearlings

Juvenile Rearing and Survival Studies: No subyearlings were reared in 1998. Methods were described in previous annual reports.

Adult Survival Studies: Methods to determine SAR were the same as described for fall chinook salmon.

Fall Release

Juvenile Rearing and Survival Studies: No fish for fall release were reared in 1997-98. Methods were described in previous annual reports.

Adult Survival Studies: Methods to determine SAR were the same as described for fall chinook salmon.

Yearlings

Juvenile Rearing and Survival Studies: Methods in rearing and survival studies were the same as described for subyearling fall chinook salmon. Eyeing percent from 15 family groups representing Umatilla stock incubated at different initial temperatures was evaluated. Hatch and swim-up percents were determined for 9 Umatilla family groups. Methods to PIT-tag smolts were the same as described for yearling fall chinook salmon except that fish from UFH were collected from raceways, tagged at IFH (approximately 250 fish/raceway) and held 48 h in circular tanks. To test smolt tolerance to saltwater, an indication of readiness, three random samples of five fish from UFH and LWS were held for 24 h in either an aerated static saltwater treatment (30 ppt) or an aerated static freshwater control. Blood chemistry including hematocrit, and blood sodium from each fish were compared between control and treatment within each hatchery.

Adult Survival Studies: Methods to determine SAR were the same as described for fall chinook salmon.

Adult Returns to the Umatilla River

Methods to collect data on spring chinook salmon returns and determine survival estimates were the same as described for fall chinook salmon.

Fishery

The spring chinook salmon sport fishery was closed in 1998.

Statistical Analyses

Methods to analyze data were the same as fall chinook salmon. Percent eye and hatch data was arcsin transformed and analyzed with paired *t*-tests (α=0.05). In the salt water challenge test parameters were analyzed with analysis of variance to determine if there were significant differences ($P<0.05$).

Results

Subyearlings

Overview: One brood (1991) of subyearling spring chinook salmon was reared in OR raceways and three broods (1991-93) were reared in MI raceways at UFH and released in the Umatilla River (Appendix Table 4). The objectives of this study were to evaluate the subyearling rearing strategy and to compare rearing conditions and cost, juvenile migration, and SAR between subyearlings produced in MI and OR systems and among passes within MI system. Adult returns will be completed in 1999.

Juvenile Rearing and Survival Studies: No subyearlings were reared at UFH in 1998. Juvenile data at pre-release and release were presented in earlier annual reports (Keefe et al. 1993 and 1994).

Adult Survival Studies: Coded-wire-tag recovery data is incomplete. Since only one CWT fish has been recovered there has been no MI versus OR system or MI pass comparisons.

Fall Release

Overview: Two broods (1992-93) and three broods (1991-93) were reared in MI and OR raceways at UFH (Appendix Table 5). One brood (1991) was reared at BFH (Appendix Table 5). The objectives of this study were to compare rearing conditions and cost, juvenile migration, SAR for fish produced in MI and OR systems and among MI passes. Fish reared in OR raceways at UFH were compared to fish in OR raceways at BFH. Completed adult returns will be available in 1999.

Juvenile Rearing and Survival Studies: No fish from the 1997 brood were reared for fall release in 1998. Smolt condition and survival from previous releases were presented in Keefe et al. (1993-95) and Hayes et al. (1996-97).

Adult Survival Studies: Recovery data of previously released CWT groups are presented in Table 20. Total survival rates for all groups have been poor (<0.10%); however, survival of broods reared in MI and OR raceways were similar. Survival of the 1991 brood reared at BFH was poorer than groups reared at UFH.

Yearlings

Overview: Three broods (1993-94, and 1996) and 6 broods (1991-96) have been reared in MI and OR raceways at UFH (Appendix Table 6). Embryos at UFH are chilled to retard growth and meet size-at-

release goals. Release goals at UFH were reduced from 8 to 10 fish/lb for the 1996 brood. Eyeing and hatch were synchronized at UFH by incubating different egg takes at different temperatures. Three broods have been reared at BFH (1991-93) and one brood (1996) at LWS and Carson (CNFH) fish hatcheries (Appendix Table 6). The objectives of this study are to compare rearing conditions and cost, juvenile migration, and SAR for yearlings produced in MI and OR raceways at UFH and standard raceways at BFH, LWS, and CAR hatcheries. Completed adults returns will be available in 2002.

Umatilla Hatchery:

Juvenile Rearing and Survival Studies: Data on embryo and juvenile rearing and releases is presented in Tables 21-26 and Appendix Table 1 and 6. There was no significant difference in percent eyed among the incubated Umatilla family groups. However, the mid-range initial incubation temperature had significantly higher percent hatch and shorter swim-up length than did the lowest and highest initial incubation temperatures, respectively. Yearlings were ponded in one OR raceway on 13 May 1997 at 156 fish/lb. In July they were split into two OR raceways at 98.6 fish/lb and in August they were split into four OR and three MI raceways at 49.8 fish/lb. Baffles were removed from the MI raceways from 10 November 1997 until fish were transferred to the Imeques acclimation raceway on 9 February 1998. An average of 167 (MI) and 91 fish/gpm (OR) were produced in each raceway series. Feed conversions ranged from 1.29-1.52 in MI and OR raceways. Estimated cost per smolt was $0.34. Fish in the MI pass C were significantly shorter than the other two passes but only significantly lighter than pass B before transfer to acclimation ponds. Fish in the OR pass B were significantly lighter and longer than pass A.

Pre-release, release, and tag and marking information are presented in Tables 26-28. Fish reared in both MI and OR raceways suffered little descaling. Fish in OR raceways were judged to be 84.5% smolted compared to 36.7% in MI raceways. Coded-wire-tag retention in MI and OR raceways ranged from 96.3-100.0 %.

Results of the saltwater challenge test are presented in Table 30. Temperature in the saltwater challenge ranged from 0.0-7.2°C and tank density was less than or equal to 0.03 lb/ft^3. No fish died during the challenge. Fish from LWS were significantly smaller than UFH fish; however, both LWS (59%) and UFH (64%) fish were smolted. Fish in saltwater from LWS and UFH had significant decreases in hematocrit and increases in plasma sodium and there was a slight significant interaction between hatchery and plasma sodium with LWS treatment fish having higher plasma sodium.

Recovery data from PIT-tagged fish is presented in Table 31. Fish from MI and OR raceways were detected from 9 April – 10 May and 6-14 April May at JD and BN dams. There was no difference between length at tagging and detection at JD and BN dams.

Adult Survival Studies: CWT recovery data is presented in Table 32. Estimated number of jacks and adults recovered from 1991-93 brood years from BFH were greater than those from UFH.

Carson National Fish Hatchery:

Juvenile Rearing and Survival Studies: Fry from Carson stock collected at CNFH were ponded into one raceway on 9 January 1997. They were split into three standard raceways in the third week of May 1997 for final rearing at an average of 66 fish/gpm. Tag retention of CWT fish was 97.2%. Fish transferred to the Imeques acclimation facility on March 13, 1998 were judged to be intermediate in smolt development and 12% and 85% were descaled and partially descaled. Average length, weight, and condition factor at release from the acclimation raceways were 134.0 mm, 27.9 g, and 1.14. Mark and

recovery data of PIT-tagged fish is presented in Tables 29-30. These fish were detected from May 6-26 and May 9-29 at JD and BN dams. There was no difference between mean length at tagging and mean length of detected fish at both dams.

Adult Survival Studies: Adult returns will be completed in 2002.

Little White Salmon Fish Hatchery:

Juvenile rearing and Survival Studies: Eggs were collected from Carson stock at LWS. Green eggs were transported to UFH in August 7-15, 1996 to accelerate early rearing. Fingerlings were transferred and ponded to LWSH for final rearing in standard raceways at an average of 73 fish/gpm. Tag retention of CWT fish was 97.6 % for both release groups. Fish were transferred to Imeques acclimation raceways on February 18 and March 11, 1998. Smolt development for the second release was judged to be intermediate 31.9 % with none descaled and 9.6 % partially descaled. Average lengths, weights, and condition factors at release on March 8 and April 14 were 135.5 and 148.1 mm, 29.0 and 38.9 g, and 1.17 and 1.17. Mark and recovery data of PIT-tagged fish are presented in Tables 29-30. These fish were detected from May 6-26 and May 9-29 at JD and BN dams. For each release group there was no difference between length at tagging and detection at JD and BD dams.

Adult Survival Studies: Adult returns will be completed in 2002.

Adult Returns to the Umatilla River

Fish counts from 1998 and vital statistics from 1995-98 to TMFD are presented in Tables 33-34 and Appendix Table 8. The 1998 adult and jack runs began on April 16 and May 11, peaked on May 16 and 27, and ended on June 29 and 22 (Figure 3).

Fishery

There was no sport fishery for spring chinook salmon in 1998 because of low adult returns.

Discussion

Subyearlings

Because of low SAS, the subyearling strategy to meet chinook salmon restoration goals was discontinued at UFH.

Fall Release

Smolt-to-adult survival for the fall release strategy is below the 0.4% goal (CTUIR and ODFW 1990) for UFH. However, the 1993 brood reared at UFH was larger at release than previous broods and had greater survival. We recommend further investigation of this release strategy. Ewing and Ewing (1995) showed that SAS increases as rearing densities decrease. Lower juvenile densities, no baffle related injuries, smaller release size, and over-wintering in the acclimation ponds at ambient temperatures may all contribute to increases in SAS.

Yearlings

Yearling SAS from UFH is well below the 0.75% goal (CTUIR and ODFW 1990). Survival of fish reared at UFH is consistently poorer than SAS of fish reared at BFH. Release size for the UFH 1996 brood was similar to the release size of 1991-93 broods at BFH because size was retarded during embryonic development with chilled incubation water. Prolonging development and hatching with cold incubation is well documented, but causes lower eyeing, hatching, and swim-up survival if the temperatures are below species tolerance (Stonecypher et al. 1994). The optimum temperature range for chinook salmon during embryonic development is 4-12°C, but survival varies among stocks and families (Murray and Beacham 1986). Our study indicated good eyeing and hatching survival for this stock at 8.0-9.8°C. We recommend incubating at these temperatures throughout embryo development to produce smaller juveniles at release.

Water quality at UFH during juvenile rearing is within standards for salmonid culture (Piper et al. 1986). In experimental MI raceways oxygen is maintained at saturation. Un-ionized ammonia (*u*g/l) increases in continued MI passes, however, it never exceeds levels recommended for salmonid culture (Tarazona and Muñoz 1995). We recommend reducing the measuring of water quality parameters, unless there are production changes requiring monitoring or evaluation.

A preferred release size or time could not be determined from releases in 1998; detection rates of PIT-tagged fish from all groups were similar. Ten percent of the LWS fish released (40 g) in April were detected compared to 4-12% of UFH fish (39 g) released in March. Detection of LWSH fish (29 g) released March was 3% compared to 12% of CFH fish (29g) released in April. We recommend continued monitoring of size- and time-at-release to evaluate and improve juvenile survival.

The saltwater challenge test indicated that LWS and UFH fish had similar seawater readiness. LWS fish had a greater range of plasma sodium than UFH fish, but the effect on SAS is unknown. Others found that plasma sodium may aid in determining release timing, but variations caused by temperature, photoperiod, or stock could not be interpreted (Clarke 1982 and Yeoh et al. 1991). There is no clear advantage to continuing the saltwater challenge evaluation because it cannot predict optimum release size or time.

Adaptive management recommendations should increase SAS and reduce cost of UFH releases per adult recovery by mimicking strategies at BFH that produce higher SAR. Reducing release size of UFH fish to 10 fish/lb was adopted because of the greater SAR of smaller release size of BFH fish. We recommend continued evaluation of the changes made in the culture program to improve SAR of yearling chinook salmon reared in MI and OR raceways at UFH.

Adult Returns to the Umatilla River

The 1998 return of 429 jacks and adults was 25 % of two previous years and lower than the 8 year average of 1,207 fish. Returns are well below the master plan goal of 10,000 hatchery adults. Adults produced from yearling smolts from BFH still comprise the majority of the run. In 1999 the predicted adult return to TMFD is 731 (267-1195, 95% CI). However, 4-year-olds will be entirely from UFH releases and the reliability of the adult predictor for this group is unknown.

Table 20. Exploitation and survival of spring chinook salmon reared at Umatilla and Bonneville hatcheries, coded-wire-tagged (CWT) and released in the fall in the Umatilla River, 1990-93 broods. Recoveries include age 3 and older fish. Brood year 1991 data is complete, other broods are incomplete. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in January 1999.

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
			Umatilla Hatchery			
1991						
071542	O3B	0	0.0	0.00	0.00	0
071543	O3A	3	0.0	0.01	0.01	6
Total/Average		3	0.0	0.01	0.01	6
1992						
070159	M2A	3	0.0	0.01	0.01	4
070160	M3A	4	0.0	0.01	0.01	6
070161	M2B	0	0.0	0.00	0.00	0
070162	M3B	9	0.0	0.03	0.03	12
070163	M3C	2	0.0	0.01	0.01	3
070216	M2C	4	0.0	0.01	0.01	5
Subtotal/Average		22	0.0	0.01	0.01	28
070155	O2A	3	0.0	0.01	0.01	3
070156	O3B	0	0.0	0.00	0.00	0
070157	O2B	0	0.0	0.00	0.00	0
070158	O3B	4	0.0	0.01	0.01	5
Subtotal/Average		7	0.0	0.01	0.01	8
Total/Average		29	0.0	0.01	0.01	38
1993						
070724	M2C	15	0.0	0.04	0.04	17
070725	M3C	19	0.0	0.05	0.05	20
070726	M2B	23	0.0	0.07	0.07	25
070727	M3B	15	0.0	0.04	0.04	16
070728	M2A	11	0.0	0.03	0.03	12
070729	M3A	12	0.0	0.03	0.03	14
Subtotal/Average		95	0.0	0.04	0.05	104
070730	O2A	27	0.0	0.07	0.08	28
070731	O1A	28	0.0	0.08	0.08	29
070732	O2B	20	0.0	0.06	0.06	20
070733	O1B	28	0.0	0.08	0.08	28
Subtotal/Average		103	0.0	0.07	0.07	105
Total/Average		198	0.0	0.06	0.06	209

[a] *Expanded CWT recoveries.*

Table 20 (continued)

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
			Bonneville Hatchery			
1991						
076042	A11	15	6.7	0.06	0.06	15
076043	A10/A11	12	25.0	0.04	0.05	12
076044	A10	5	0.0	0.03	0.03	5
076045	A9	12	0.0	0.05	0.05	12
076046	A8/A9	20	0.0	0.08	0.08	20
076047	A8	8	0.0	0.05	0.05	8
Total/Average		72	5.3	0.05	0.05	72

Table 21. Egg-take and survival of yearling spring chinook salmon reared at Umatilla Hatchery, 1991-96 broods. All eggs are Carson stock.

Egg source	Brood year	Number of eggs taken or received	Egg-to-fry survival (%)	Egg-to-smolt survival (%)[a]
Carson NFH	1991	332,000	97.2	93.4
Carson NFH	1992	319,000	71.3	67.4
Carson NFH	1993	314,000	66.6	61.8
Ringold/Lyons Ferry	1994	602,000	71.8	58.8
Carson NFH, Lyons Ferry/ Little White Salmon	1995	226,000	96.3	99.7
Little White Salmon, Umatilla, Carson NFH	1996	487,612	80.2	78.6

[a] *Survival is based on green egg-to-smolt stage.*

Table 22. Eyeing and hatching survival of spring chinook salmon embryos from Umatilla stocks incubated at different temperatures. Means with the same letter are not significantly different at P>0.05.

Family Groups[a]	Initial incubation temperature°C	Percent eyed	Percent hatch	Swim-up length(mm)
4,5,6	4.0	86.7 (17.7)a	81.0(17.3)a	24.3(1.4)ab
1	7.6	53.7		
46,48,51,53	8.0	99.0 (0.5)a	96.7(3.1)b	24.4(0.6)b
2,3,39,42,52	9.2	98.4 (0.7)a	93.3(2.3)ab	25.5(0.6)a
31,34	9.8	99.8 (0.2)		

[a] *Family groups 1-3,31,34, and 52 were moved to Little White Salmon National Fish Hatchery at eye stage.*

Table 23. Rearing conditions immediately before transfer for yearling spring chinook salmon in Michigan or Oregon raceways at Umatilla, Bonneville, Little White Salmon, and Carson hatcheries, brood years 1991-96.

Brood year	System	Maximum density (lb/ft^3)	Maximum loading (lb/gal/min)
	Umatilla Hatchery		
1991	Oregon	1.0	5.0
1993	Oregon	0.9-1.1	4.6-5.4
1994	Michigan	2.4-2.7	5.9-6.6
	Oregon	1.2-1.3	5.6-6.2
1995	Oregon	1.0	4.8-4.9
1996	Michigan	2.0	4.9
	Oregon	0.9	4.2
	Bonneville Hatchery		
1991	Oregon	0.6-0.7	5.0-5.3
1992	Oregon	0.8-1.0	6.8-9.8
1993	Oregon	0.7-0.8	4.9-6.2
	Little White Salmon Hatchery		
1996		0.6-0.7	5.0-5.3
	Carson National Fish Hatchery		
1996		1.7	5.0

Table 24. Water quality measurements in Michigan and Oregon raceways used to rear yearling spring chinook salmon in 1997-98. Sampling period was August 8 to January 30. Means are combined values for first and second pass raceways (* = significant difference between systems, NS = no significant difference, P>0.05).

	Mean parameter value				
Parameter measured	N	Michigan	N	Oregon	t-test
Temperature head (°C)	24	13.5	23	13.6	NS
Temperature tail (°C)	24	13.6	23	13.6	NS
pH head	27	7.7	26	7.8	NS
pH tail	27	7.8	26	7.8	NS
Oxygen head (ppm)	24	10.1	23	9.6	*
Oxygen tail (ppm)	24	9.4	23	8.8	*
Nitrogen head (mmHg)	24	605	23	614	*
Nitrogen tail (mmHg)	24	614	23	623	*
Total pressure-head (mmHg)	24	757	29	759	NS
Total pressure-tail (mmHg)	24	753	29	757	NS
Unionized ammonia (µg/l)	9	0.80	9	0.97	NS
Alkalinity (mg/l $CaCO_3$)	6	137	6	137	NS

Table 25. Water quality measurements among first, second, and third pass Michigan raceways used to rear yearling spring chinook salmon in 1997-98. Sampling period was August 1 to January 30. Means with the same letter or without letters are not significantly different at P>0.05.

	Mean parameter value (N)			
Parameter measured	N	A pass	B pass	C pass
Temperature head (°C)	27	13.5	13.6	13.6
Temperature tail (°C)	27	13.5	13.6	13.6
pH head	27	7.7	7.8	7.8
pH tail	26	7.7	7.8	7.8
Oxygen head (ppm)	24	10.1	10.1	10.3
Oxygen tail (ppm)	24	9.4	9.4	9.5
Nitrogen head (mmHg)	38	606	605	604
Nitrogen tail (mmHg)	38	609	610	611
Total pressure-head (mmHg)	38	758	757	759
Total pressure-tail (mmHg)	37	754	753	754
Unionized ammonia (µg/l)	19	0.36x	1.24xy	1.51y
Alkalinity (mg/l $CaCO_3$)	20	137	138	137

Table 26. Mean length, weight, and condition factor for yearling spring chinook salmon reared in Michigan and Oregon raceways at Umatilla Hatchery during 1997-98, 1996 brood. Means with the same letter are not significantly different (P>0.05).

		Length(mm)		Weight(g)		Condition Factor	
Sample	Pass	N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
				Michigan			
August:	A	104	86.7(0.5)	55	9.0(0.2)	55	1.36(0.01)
	B	117	87.5(0.4)	57	9.1(0.2)	57	1.33(0.01)
	C	110	88.6(0.4)	52	9.2(0.2)	52	1.33(0.01)
September:	A	103	101.3(0.7)	56	14.3(0.4)	56	1.33(0.01)
	B	107	98.1(0.5)	46	12.6(0.3)	46	1.31(0.01)
	C	109	101.3(0.6)	50	13.1(0.4)	50	1.31(0.01)
October:	A	111	110.6(0.7)	58	18.7(0.5)	58	1.34(0.01)
	B	109	110.5(0.7)	55	18.2(0.6)	55	1.32(0.01)
	C	104	110.0(0.7)	67	17.4(0.5)	67	1.31(0.01)
November:	A	109	120.3(0.9)	59	22.5(0.8)	59	1.30(0.01)
	B	105	119.9(0.7)	52	22.8(0.6)	52	1.30(0.02)
	C	108	121.2(0.7)	54	22.9(0.6)	54	1.25(0.01)
Pre-release:	A	313	147.7(0.7)a	117	39.7(0.9)a	117	1.21(0.01)a
	B	303	147.7(0.7)a	119	40.8(0.9)b	119	1.22(0.01)b
	C	306	145.7(0.7)b	112	39.2(1.0)a	112	1.21(0.01)a

Table 26 (continued)

Sample	Pass	Length(mm) N	Length(mm) Mean(SE)	Weight(g) N	Weight(g) Mean(SE)	Condition Factor N	Condition Factor Mean(SE)
			Oregon				
June:	A	97	60.2(0.3)	61	2.9(0.1)	61	1.29(0.01)
July:	A	235	72.9(0.3)	109	4.6(0.1)	109	1.18(0.01)
August:	A	200	88.4(0.3)	104	9.2(0.1)	104	1.33(0.01)
	B	217	88.7(0.3)	104	8.9(0.1)	104	1.27(0.01)
September:	A	198	101.5(0.4)	101	13.7(0.2)	101	1.28(0.01)
	B	204	101.7(0.3)	104	13.8(0.2)	104	1.29(0.01)
October:	A	209	109.6(0.5)	106	17.3(0.3)	106	1.31(0.01)
	B	222	109.6(0.4)	106	17.4(0.3)	106	1.29(0.01)
November:	A	209	120.7(0.5)	133	23.7(0.4)	133	1.33(0.01)
	B	213	122.4(0.5)	106	24.1(0.5)	106	1.30(0.01)
Pre-release:	A	614	145.6(0.5)a	231	40.6(0.7)a	231	1.27(0.00)a
	B	620	146.2(0.5)b	224	39.3(0.6)b	224	1.23(0.00)b
			Combined Release[a]				
		933	148.7(0.4)	638	38.9(0.4)	638	1.16(0.00)

[a] *Fish were sampled from three acclimation ponds on March 8, 1998.*

Table 27. Mean length, weight, and condition factor at pre-release or release for yearling spring chinook salmon reared in Michigan or Oregon raceways at Umatilla Hatchery, 1991-1996 broods (standard error in parentheses).

Brood year	System	Length (mm)	Weight (g)	Condition factor
1991[a]	Oregon	158.8(0.0)	50.5(0.0)	1.20(<0.01)
1992	Oregon	163.0(0.7)	55.2(1.3)	1.23(0.01)
1993[b]	Michigan	166.9	57.8	1.24
	Oregon	171.0	56.9	1.16
1994[b]	Michigan	160.9	46.4	1.11
	Oregon	167.7	53.0	1.12
1995[b]	Oregon	149.22	45.9	1.35
1996	Michigan	147.1(0.4)	39.9(0.5)	1.21(<0.01)
	Oregon	145.9(0.3)	40.0(0.5)	1.25(<0.01)

[a] *Brood years 1991-92 were not acclimated and were released directly into the Umatilla River.*

[b] *Fish from the 1993 through 1995 brood years were measured at release after acclimation, standard errors were not available.*

Table 28. Mean proportion of descaled, partially descaled, and undamaged yearling spring chinook salmon reared in Michigan and Oregon raceways at Umatilla Hatchery, brood years 1991-96.

Brood year	System[a]	Descaled[b]	Partially descaled[c]	Undamaged[d]
1991	Oregon	0.01	0.01	0.99
1992	Oregon	0.01	0.18	0.81
1993	Michigan	0.03	0.24	0.74
	Oregon	0.00	0.15	0.85
1994	Michigan	0.13	0.54	0.33
	Oregon	0.01	0.12	0.87
1995	Oregon	0.01	0.13	0.86
1996	Michigan	0.00	0.17	0.83
	Oregon	0.01	0.24	0.76

[a] *Oregon system combined first and second passes and Michigan system first and second raceway passes combined.*

[b] *More than 0.20 descaling on either side of the fish.*

[c] *Descaling = 0.03 to 0.20 on either side of the fish.*

[d] *Less than 0.03 descaling on either side of the fish.*

Table 29. Tag and mark information for yearling spring chinook salmon reared at Umatilla, Little White Salmon, and Carson fish hatcheries and released in the Umatilla River in 1998, 1996 brood. (CWT = coded wire tag, AD = adipose fin, LV = left ventral fin).

Raceway	Release date[a]	CWT code	Number CWT[a]	Fin clip	Number PIT-tagged fish released[c]	PIT-tags extruded after 48 h (%)	PIT-tag mortalities after 48 h (%)	Total number released
Umatilla Hatchery								
M2A	March 8	092256	23,162[b]	ADLV	248	3.1	0.0	52,159
M2B	March 8	092257	22,788	ADLV	243	4.7	0.0	51,972
M2C	March 8	092258	22,450	ADLV	240	5.9	0.0	51,743
O5A	March 8	092259	23,247	ADLV	237	6.7	0.0	60,277
O4A	March 8	092260	22,759	ADLV	247	3.1	0.0	59,744
O5B	March 8	092261	23,248	ADLV	233	8.6	0.0	53,502
O4B	March 8	092262	23,778	ADLV	244	2.0	0.0	53,317
Little White Salmon Hatchery								
46	March 8	071420	19,403	ADLV	235	3.1	4.7	172,999
48	April 14	075743	19,255	ADLV	244	0.8	3.5	172,258
Carson National Fish Hatchery								
37-40	April 14	076036	18,721	ADLV	241	2.4	3.1	99,641

[a] *Number recognizably coded-wire-tagged and released. All fish with CWT were adipose fin clipped*
[b] *2,280 fish adipose fin clipped only and 11,351 fish were adipose and right ventral fin clipped.*
[c] *PIT-tag tagging files for raceways WAC98015.O4A, WAC98015.O4B, WAC98015.M2A, WAC98015.M2B, WAC98015.M2C, WAC98016.O5A, WAC01626.O5B, WAC98050.IMQ,.*

Table 30. Salt water challenge test (30 parts per thousand) for yearling chinook salmon from Umatilla and Little White Salmon hatcheries and released into the Umatilla River in 1998. Means with different letters are significantly different (P<0.05). Standard errors are in parentheses.

	Little White Salmon		Umatilla	
Parameter	Treatment	Control	Treatment	Control
Fork Length (mm)	134.7(1.5)c	135.4(3.4)c	150.1(2.6)d	159.1(2.1)e
Weight (g)	27.3(1.0)a	29.1(2.7)a	36.0(1.9)b	44.0(1.8)b
Hematocrit (%)	41.9(1.9)u	50.0(1.2)v	46.1(1.0)w	53.2(1.4)x
Plasma sodium concentration (mM)	187.7(1.8)x	127.9(2.2)y	184.3(1.7)x	134.3(3.1)z

Table 31. Number and percent detected, median travel time, and median detection date at John Day and Bonneville dams for yearling spring chinook salmon, PIT-tagged, and released in the Umatilla River, spring 1998.

		John Day			Bonneville		
Raceway	CWT code	Percent detected (Number)	Median travel time (d)	Median detection date	Percent detected	Median travel time (d)	Median detection date
Umatilla Hatchery[a]							
M2A	092256	12.1(30)	43	April 20	3.6(9)	52	April 29
M2B	092257	7.4(18)	45	April 22	5.8(14)	50	April 27
M2C	092258	8.8(21)	42	April 19	5.0(12)	49	April 26
O5A	092259	3.8(9)	49	April 26	2.5(6)	53	April 30
O4A	092260	8.1(20)	45	April 22	4.0(10)	49	April 26
O5B	092261	7.7(18)	48	April 25	5.2(12)	56	May 3
O4B	092262	11.1(27)	48	April 25	4.5(11)	52	April 29
Little White Salmon Hatchery[a]							
46	071420	3.0(7)	56	May 3	1.7(4)	57	May 4
48	075743	10.2(25)	24	May 8	4.1(10)	24	May 8
Carson National Fish Hatchery[a]							
37-40	076036	12.0(29)	30	May 14	6.2(15)	34	May 18

[a] *Fish from Umatilla Hatchery and raceway 46 from Little White Salmon Hatchery were released on March 8, 1998; Fish from Carson Hatchery and raceway 48 from Little White Salmon Hatchery were released on 14 April 1998.*

Table 32. Exploitation and survival of yearling spring chinook salmon that were reared at Umatilla and Bonneville hatcheries, coded-wire-tagged (CWT) and released in the Umatilla River, 1991-93 broods. Recoveries include age 3 and older fish. Brood year 1991 is complete, other brood years are incomplete. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in January 1999.

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
			Umatilla Hatchery			
1991						
075739	O5B	3	0.0	0.01	0.01	7
075740	O4B	3	0.0	0.01	0.01	7
075741	O4A	16	0.0	0.08	0.08	41
075742	O5A	8	0.0	0.04	0.04	21
Total/Average		30	0.0	0.04	0.04	76
1992						
070217	O5A	0	0.0	0.00	0.00	0
070218	O5B	14	0.0	0.07	0.07	35
070219	O4B	9	0.0	0.04	0.04	23
070220	O4A	22	4.5	0.10	0.11	54
Total/Average		45	1.5	0.05	0.05	112
1993						
071453	M5A	4	0.0	0.02	0.02	7
071454	M5B	10	0.0	0.06	0.06	26
Subtotal/Average		14	0.0	0.04	0.04	33
070651	O4A	4	0.0	0.02	0.02	10
070652	O4B	8	0.0	0.04	0.04	19
070653	O5B	18	0.0	0.10	0.10	39
070654	O5A	1	100.0	0.00	0.01	0
Subtotal/Average		31	25.0	0.04	0.04	68
Total/Average		45	16.7	0.04	0.04	101
1994						
071027	M6A	1	0.0	0.01	0.01	2
071028	M6B	0	0.0	0.00	0.00	0
071029	M6C	0	0.0	0.00	0.00	0
Subtotal/Average		1	0.0	0.00	0.00	2

[a] *Expanded CWT recoveries.*

Table 32. (continued).

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
1994						
071030	O4A	0	0.0	0.00	0.00	0
071031	O5A	0	0.0	0.00	0.00	0
071032	O5B	3	0.0	0.01	0.01	9
071033	O4B	0	0.0	0.00	0.00	0
Subtotal/Average		3	0.0	0.00	0.00	9
Total/Average		4	0.0	0.00	0.00	11
1995						
091730	O4A	1	0.0	0.01	0.01	3
091749	O5A	5	0.0	0.03	0.03	14
091750	O4B	3	0.0	0.01	0.01	8
091751	O5B	0	0.0	0.00	0.00	0
Total/Average		9	0.0	0.01	0.01	25
1996						
092256	M2A	0	0.0	0.00	0.00	0
092257	M2B	0	0.0	0.00	0.00	0
092258	M2C	0	0.0	0.00	0.00	0
Subtotal/Average		0	0.0	0.00	0.00	0
092259	O5A	0	0.0	0.00	0.00	0
092260	O4A	0	0.0	0.00	0.00	0
092261	O5B	0	0.0	0.00	0.00	0
092262	O4B	0	0.0	0.00	0.00	0
Subtotal/Average		0	0.0	0.00	0.00	0
Total/Average		0	0.0	0.00	0.00	0
Bonneville Hatchery						
1991						
071455	B1	45	6.7	0.21	0.23	102
071456	B2	33	9.1	0.15	0.17	76
Total/Average		78	7.9	0.18	0.19	178
1992						
070250	B6	142	1.4	0.52	0.53	529
070251	B5	140	5.7	0.50	0.53	538
075944	B8	113	2.7	0.54	0.56	584
075945	B7	80	2.5	0.39	0.40	394
Total/Average		475	3.1	0.51	0.50	2,045

Table 32 (continued)

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
1993						
070649	B7	146	0.0	0.65	0.66	805
070650	B8	160	0.0	0.66	0.66	828
070660	B5	82	6.1	0.32	0.35	247
070661	B6	168	1.8	0.57	0.58	430
Total/Average		556	1.9	0.55	0.56	2,310

Table 33. Number of spring chinook salmon that returned to the eastbank fish ladder, Three-Mile Falls Dam, Umatilla River, 1995-98.

	Male		Female		Unknown		Total	
Age[a]	Number	Percent	Number	Percent	Number	Percent	Number	Percent
				1995				
Subjack	26	100.0	0	0.0	0	0.0	26	5.2
Jack	82	100.0	0	0.0	0	0.0	82	16.5
Adult	162	41.8	224	57.7	2	0.0	388	78.2
Total	270	54.4	224	45.2	2	0.4	496	100.0
				1996				
Subjack	0	0.0	0	0.0	0	0.0	0	0.0
Jack	121	100.0	0	0.0	0	0.0	121	5.3
Adult	948	44.1	1204	55.9	0	0.0	2152	94.7
Total	1,069	47.0	1,204	53.0	0	0.0	2,273	100.0
				1997				
Subjack	0	0.0	0	0.0	0	0.0	2	0.0
Jack	4	100.0	0	0.0	0	0.0	4	0.2
Adult	968	44.2	1223	55.8	0	0.0	2192	99.7
Total	972	44.3	1,223	55.6	1	0.1	2,198	100.0
				1998				
Subjack	0	0.0	0	0.0	0	0.0	0	0.0
Jack	20	100.0	0	0.0	0	0.0	20	4.7
Adult	200	48.9	209	51.1	0	0.0	409	95.3
Total	220	51.3	209	48.7	0	0.0	429	100.0

[a] *Age designation based on fork length: subjacks <381 mm, jacks 382-610 mm, adults >610 mm)*

Table 34. Vital statistics of spring chinook salmon that returned to the eastbank fish ladder, Three Mile Falls Dam, Umatilla River in 1998 by release strategy and hatchery. Data was determined from CWT recovery (sex was determined visually).

Hatchery brood	Age	Number	Sex	Fork length (mm) Mean	Min	Max
			Fall release			
Umatilla Hatchery						
1993	5	3	male	861	834	890
1993	5	5	female	868	828	930
			Yearling			
Umatilla Hatchery						
1994	4	3	female	708	662	757
1995	3	9	male	536	475	610
Bonneville Hatchery						
1993	5	20	male	965	865	1033
1993	5	21	female	902	820	990

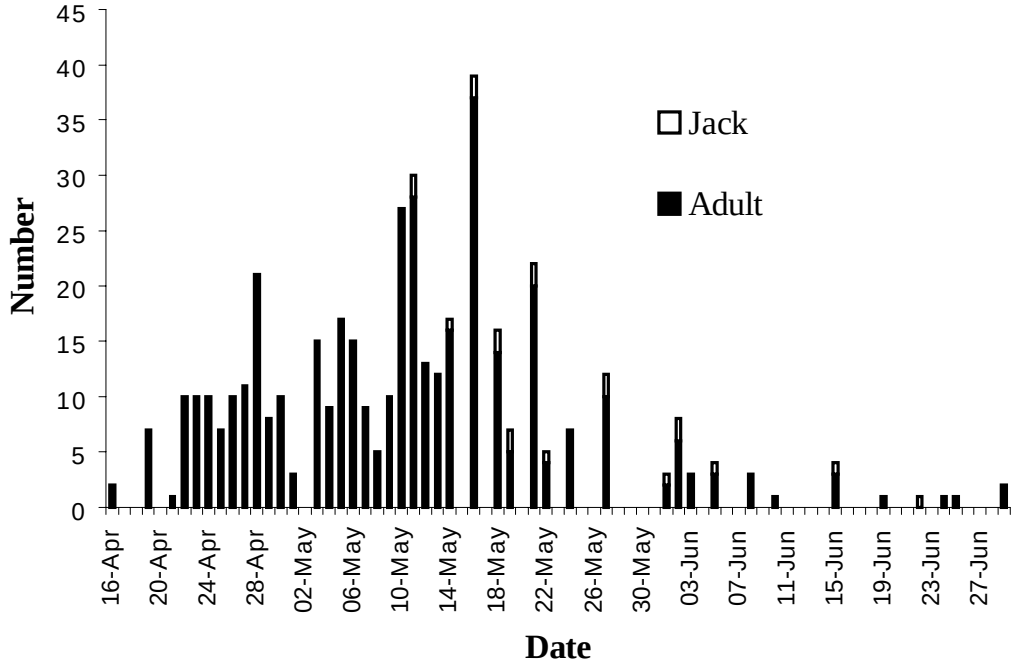

Figure 3. Numbers of jack and adult spring chinook salmon counted at the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1998.

SUMMER STEELHEAD

Overview

The objective of the steelhead evaluation is to monitor rearing conditions, cost, migration, and SAR for steelhead produced in the MI system and compare these parameters among MI passes. Seven steelhead broods (1991-97) have been reared in MI raceways at UFH and released in the Umatilla River (Appendix Table 7). Because fish are not reared in OR raceways at UFH, comparisons are being made with Imnaha and Wallowa stock steelhead reared in OR raceways at Irrigon Fish Hatchery. The original production goal of 210,000 fish was reduced to 150,000 fish after the first brood (1991) because high densities appeared to cause severe erosion of the caudal fin. Adult returns will be complete in 2002.

Methods

Juvenile Rearing and Survival Studies

Methods in rearing and survival studies and PIT tagging were the same as described for subyearling fall chinook salmon except PIT-tagging rates were 250 fish/raceway. In addition to visual estimates of fin erosion we used a ruler to measure the height of the dorsal fin and top caudal fin relative to fork length.

Adult Survival Studies

Methods to collect data on steelhead returns and survival estimates were the same as described for fall chinook salmon. Data for steelhead was downloaded from the PSMFC database in January 1999.

Adult Returns to the Umatilla River

Methods to calculate adult returns were the same as described for subyearling fall chinook salmon. All adult steelhead trapped at TMFD were classified as one- or two- ocean fish based on a 660 mm fork length cutoff for the two age groups.

Fishery

Except for the following modifications, methods to survey the steelhead sport fishery in 1997-98 were described in previous annual reports. The steelhead fishery was open from September 1, 1997 to April 15, 1998. Twenty-five of the scheduled creel days were not sampled because of high water and were considered to be zero effort and zero catch. Angling was allowed from the Umatilla mouth to the lower CTUIR boundary upstream of Pendleton. Creel surveys were focused in areas of the river with the easiest public access and at times of highest angling effort. These were the lower river (TMFD to river mouth) during the fall salmon and steelhead fishery and the upper river (Barnhart Bluffs at river mile 42 to lower CTUIR boundary) during the winter and spring steelhead fishery. Lower river surveys were completed on February 10, 1998 and upper river surveys were initiated on December 1, 1997. Rainbow trout over 20 inches in total length were considered steelhead. The legal harvest limit was 2 adipose-

clipped steelhead per day and 20 for the season. The barbless hooks only regulation was discontinued in 1998.

Statistical Analyses

Methods to analyze data were the same as those used for fall chinook salmon.

Results

Juvenile Rearing and Survival Studies

Data on juvenile rearing and survival is presented in Tables 35-38 and Appendix Tables 1 and 7. Steelhead from the 1997 brood were ponded in one OR raceway on August 31, 1997 at 246 fish/lb. From October 26-28, 1997, fish from one OR raceway were split into three MI raceways by small (A-pass, 49 fish/lb) and large grade (B- and C-passes, 33 and 30 fish/lb). Marking with CWT's and fin clips was completed in mid-November. All baffles remained in MI raceways until fish were transferred to acclimation ponds on March 19 (M8C), March 19-20 (M8B), and April 30 (M8A) 1998. Dry feed conversion ratios were similar for all passes and ranged from 0.78-0.92. The MI series of raceways produced 145 fish/gpm. Production cost, including marking was $0.67 per smolt.

Data on fish condition at release is presented in Tables 38-40. Most steelhead were intermediate smolts (85.9-96.2%) and the remainder were smolts (1.5-9.3%) and parr (0.9-4.9%). The late-released small group had the highest percentage of smolts and parr. We found that 19-25% of the caudal fins were moderately eroded in raceways M8B and M8C. No fin erosion data was collected from raceway M8A. Quantitative estimates showed the average dorsal fin height as a percentage of fork length ranged from 6.0-6.3% with a range of 2.3-11.2%. Caudal fin height averaged 11.9-12.5% and ranged from 8.1-17.3%.

Coded-wire-tag and PIT-tag release and recovery data is presented in Tables 41-44. Adipose fin clip quality was greater than 95% recognizably clipped and CWT retention ranged from 93.1-98.6%. Cumulative PIT-tag detections at JD and BN dams for the large steelhead groups (27.8-28.3%) were about double those of the small group (13.2%). Large size increased the likelihood of detection at JD and BN dams. The mean length of detected fish was significantly larger than the mean length of fish at tagging. Sample sizes of PIT-tagged fish collected at JD and BD to calculate percent detection were under the minimum required for statistical analyses. Fifty percent travel time from release to JD dam for all rearing groups combined was 28.3 d. Faster travel time to JD and BN dams for the late-released steelhead resulted in 50% detection dates only 6-9 days later than the large steelhead groups that were released about one month prior to the small group. Peak detections was on May 21 for all groups. Fish were detected from April 28 - June 7 at JD dam and April 29 - June 3 at BN dam. Travel time from JD dam to BN dam was 2.3 d (N=11) for fish detected at both dams.

Adult Survival Studies

Smolt-to-adult survival estimates are presented in Table 45.

Adult Returns to the Umatilla River

The number of fish that returned to TMFD in 1997-98 was 903 hatchery fish and 862 wild fish for a total of 1,765 (Table 46 and Appendix Table 8). Vital statistics on adults and run timing are presented in Tables 47 and Figure 4. Steelhead were trapped from August 27, 1997 to June 19, 1998. On March 15, 1998 counts peaked at 26 wild and 34 hatchery steelhead. Eighteen of eighty-eight (20%) CWT fish collected were identified as strays originating from Lyons Ferry Hatchery and releases in the Tucannon River. Expanded collection and tag codes were 4-635717, 4-635717, 3-636033, 1-636032, 1-635748), Irrigon Hatchery releases in the Wallowa River (1-071160, 2-071216), Clearwater Hatchery releases in the Clearwater River (1-102026), and Magic Valley Hatchery releases in the Salmon River (1-103511).

Fishery

Catch and harvest data for the steelhead sport fishery is presented in Tables 48-50. Angler residency in 1997-98 (N=898) was 97.5% Umatilla and Morrow counties, 1.6% other Oregon counties, and 0.9% out of state. The estimated catch of 212 steelhead below TMFD consisted of 51% hatchery and 49% wild (all wild fish were released). Anglers released 17 of 107 (16%) hatchery fish caught. Expanded CWT recoveries from 8 tags collected below TMFD by code were: 12 (070656), 4 (071035), 3 (636032), and 2 (070657). In the upriver section the estimated catch was 170 steelhead (10% hatchery and 90% wild). Descriptive statistics for the Umatilla River steelhead fishery from the 1993-94 to 1997-98 seasons is given in Table 51. The lower-river fishery has accounted for most of the harvest (73% of the harvest / 6% of the hatchery run) and hatchery steelhead catch (68%). Percent of hatchery fish in the catch (42%) has been approximately equal to their percent in the run (45%) in the lower-river fishery, but not in the upper-river fishery. In the upper river, percent of hatchery fish in the catch (30%) has been about 15% lower than their percent in the run (45%). The lower-river fishery has accounted for most of the wild steelhead catch (55% of the catch / 9% of the run). Percent of wild fish in the catch has been 3% and 15% higher than their percent in the run in the lower- and upper-river fisheries, respectively. Percent composition of the catch is predominantly wild steelhead in both the lower- (58%) and upper-river (70%) fisheries.

Discussion

Juvenile Rearing and Survival Studies

Michigan raceways at UFH have performed well by most measures for rearing juvenile steelhead since densities were reduced from about 6 lb/ft^3 to 4 lb/ft^3 following the 1991 brood. Water quality remains within acceptable limits for steelhead rearing. Dissolved oxygen typically drops from about 12 to 8 ppm through each raceway and un-ionized ammonia increases from 1 µg/l to 2-3 µg/l from the ends of the first to third pass raceway. Egg-to-smolt survival rates (60-66%) have consistently outperformed master plan expectations (53%). Since the 1994 brood, feed conversion ratios have stabilized at levels comparable to those observed with steelhead in Oregon ponds at IFH. Length at release has generally been consistent among years and raceways (2-10% variation) but fish weight has been more variable (3-27% variation). The 5 fish/lb target weight has been met in most years, but the 1997 brood was under this target (5.6 fish/lb) as were the 91 and 92 broods (5.4 and 5.5 fish/lb, respectively). We appeared to have grabbed a nonrandom sample of large fish from the B-pass fish at release this year. Monthly sampling did not corroborate that B-pass fish were unusually large. Respective weights of A-, B-, and C-pass fish were 5.5, 5.7, and 5.2 fish per pound when transferred to the acclimation sites. Fin erosion was similar to previous years with most fish suffering moderate to severe erosion of the dorsal fin (Keefe et al. 1993, 1994, Hayes et al. 1996a, 1996b, 1999 and Focher et al. 1998).

The quality of juvenile migration data was improved by PIT-tag technology. In previous years, brand and paint mark recovery rates from gatewell subsampling at JD dam were one percent or less for Umatilla steelhead and large expansion factors were used to estimate dam passage. PIT-tag detection rates of 8.7-18.0% are an improvement but are still low compared with detection rates of steelhead at other dams. Detection rates of 50-70% are typically observed for steelhead released in the Grand Ronde basin when they passed their first mainstem Snake River dam (personal communication, T. Whitesel, ODFW, Portland, OR). It is uncertain whether low detection rates for Umatilla steelhead represent poor survival or low bypass collection efficiency at JD dam. Collection efficiency of the current fish guidance system at JD dam has not been evaluated.

PIT-tag data is useful for gauging relative survival of release groups. Comparisons are most appropriate for groups that are released and pass the dams simultaneously and are subject to the same bypass collection efficiencies. This condition was met for the two groups of large steelhead released in mid-April. Both groups had similar migration timing to and detection at JD and BN dams. It is unknown how comparable detection rates are between the early-released large and late-released small groups. Though the two large groups were detected on average one week earlier than the small group, highest detections occurred over the same four-day period for all groups. Respective outflow and percent spill at JD dam before and after this period of high detection averaged 330/394 kcfs and 35/40%. These flow conditions suggest collection efficiency of the bypass might have been 10-15% higher for the early-arriving large groups. Assuming detection rates for the small and large groups were comparable, relative survival of the smalls (48%) to JD dam was higher than expected when compared to adult survival estimates (5-20%) of previous broods. However, juvenile survival data may not be an accurate predictor of adult survival. To date, CWT recoveries are complete for two broods with accompanying brand recoveries at JD dam. Relative survival of the smalls based on brand recoveries from these two broods overestimated their subsequent adult survival 2.7- and 12.9-fold.

Release protocol for the small group was varied this year by allowing fish to volitionally release for one week and force-releasing one week earlier than previous releases. Our first detection at JD dam was only 13 d after the initiation of volitional release. Changes in the release strategy for the smalls was prompted by greater SAR for the early-released large groups and outmigration monitoring (Knapp et al. 1996, 1998a, 1998b) which suggested river conditions were more conducive for successful outmigration in early May than late May. It is uncertain whether this new release strategy was linked with what appears to be better than normal juvenile survival this year. We recommend continuing the volitional release strategy for the smalls and adopting it for the large groups. Releasing the larges' a week earlier will allow earlier transfer and release of the small group. We should also consider acclimating the small group lower in the river (Minthorn) where they can be released into the mainstem. Their current release site (Bonifer Pond, Meacham Creek) introduces them into a tributary stream which may encourage residency more than a lower release site. Radio-telemetry or marking and snorkeling studies could provide needed information on the extent of residualism associated with the various release groups.

Adult Survival Studies

The master plan goals incorporated a SAR rate of 2.7% for steelhead reared in MI raceways at UFH (ODFW and CTUIR 1990). This survival rate would produce 4,050 adults given current releases of 150,000 smolts. Survival of the 1991-94 broods has been well below this projection. Smolt-to-adult survival was only 0.08% for the first brood (1991) reared at high density and released in a drought year. The following three broods averaged 0.70% SAR. Two-thirds of the production (early-released larges) has performed better than indicated by this average. Survival of large steelhead has averaged 0.83% (0.50-1.42%) compared with 0.13% (0.01-0.27%) for small steelhead. Information collected thus far

suggests the pre-hatchery projection for 2.7% SAR was too high. However, several uncertainties still remain. It is unknown whether the lower than projected performance of steelhead was an outcome of erroneous assumptions in the model used to predict survival, poorer than anticipated environmental conditions, or rearing in MI raceways. Poor survival of the 1991 brood was likely associated with drought river conditions or high rearing densities in the hatchery. However, rearing conditions and release time, size, and location have been consistent since the 92 brood. Factors that may have influenced steelhead SAR during the early 1990s, in addition to natural fluctuations in the environment, were the completion of fish passage facility reconstruction and flow augmentation projects on the Umatilla River. Completion of these projects in 1995 coincided with high survival of steelhead released that year (94 brood). Survival of the 94 brood increased more than three-fold from previous broods. During this same time frame, survival of steelhead released into the nearby Walla-Walla and Grande Ronde basins remained relatively stable. More SAR information is needed to adequately define what a "normal" range of SAR rates are for Umatilla River steelhead. Whether steelhead reared in OR raceways can outperform MI-reared steelhead will remain unanswered unless side-by-side tests of these two rearing systems are conducted.

Adult Returns to the Umatilla River

Supplementation goals for UFH were to build-up the natural steelhead returns to 4,000 fish in five years. This was an optimistic time-line that assumed the first returns of hatchery adults would be a large run that spawned successfully, freshwater habitat was available for the increased numbers of juvenile steelhead, offspring of hatchery adults would survive in freshwater and marine environments as well as natural offspring, and the freshwater and marine environments would remain favorable for high survival. We are now at the five year mark and there is no definitive evidence that natural steelhead production has increased. The lack of a significant increase in natural production could be due to not meeting any of the above assumptions. We know numbers of adult hatchery fish returning to spawn have been lower than expected, particularly for the 1991 brood. However, we do not know at this time whether any of the other assumptions have been met. Monitoring efforts are currently underway that will provide information needed to answer most of these uncertainties. Natural production (Contor et al. 1995, 1996, 1997), outmigration (Knapp et al. 1996, 1998a, 1998b), and hatchery (Keefe et al. 1993, 1994; Hayes et al. 1994, 1995, 1997 1999; Focher et al. 1996) monitoring are providing information on habitat availability, smolt production, outmigration success, adult production, and life history. However, some critical information is still needed to evaluate the supplementation program. Sampling techniques are not currently available to evaluate the key uncertainty of supplementation; whether the offspring of hatchery fish survive as well as their natural counterparts in the wild. Established trapping and monitoring programs in the Umatilla River could provide supporting logistics that will be needed to develop and evaluate future sampling techniques. We should be proactive in seeking opportunities to promote and participate in such endeavors. Radio-tracking could be used to increase our knowledge of the distribution and interactions of hatchery and natural spawners. More information is also needed on the availability and use of winter habitat by juvenile steelhead in the Umatilla River.

The Umatilla Hatchery steelhead program has increased the numbers of potential spawners though these increases have been well below master plan projections. An average of seven hatchery adults have returned to the Umatilla River and escaped the in-river fishery for each fish spawned from brood years 1991-94 (e.g. progeny:parent - escapement ratio = 7:1). Progeny:parent - escapement ratios have ranged from 1:1 for the 1991 brood which was released in a drought year to 5:1-14:1 for the three subsequent broods. Since approximately 100 fish are removed from the run for broodstock (88% natural, 12% hatchery origin) each year, the net effect of the hatchery program on escapement has been an average of 647 additional adults per year. Hatchery escapement has ranged from 170 adults for the 1991 brood to a

high of 1,355 adults for the 1994 brood. This is far below the projected increase in escapement of 3,600 adults that would result from a 2.7% smolt-to-adult return rate to the Umatilla River mouth (36:1 progeny-escapement ratio). Higher and more consistent adult production from steelhead reared at UFH will be a prerequisite to meeting the supplementation goals outlined in the master plan. We recommend three possible actions for improving adult production of steelhead reared at UFH: 1) return to the original master plan goal of releasing 210,000 juvenile steelhead, 2) modify release strategies as described in juvenile rearing and survival section (earlier forced-release time with one week of volitional release), and 3) conduct side-by-side evaluation of MI and OR rearing systems. Of these three options, only the first is certain to increase adult production.

The proportion of stray steelhead that entered the Umatilla River in 1998 was about 40% above average. Stray rates are influenced by many factors including relative sizes of the home and stray populations, geographic proximity of populations, and water quality. Water quality may have exerted a stronger influence than usual this year because flow in the Umatilla River remained moderate with fewer floods which resulted in better water quality. Although strays accounted for 20% of the CWTs recovered from hatchery fish, we estimated they composed only 12% of the total run (204 of 1765 fish). The majority of strays have originated from Lyons Ferry and IFH releases into other nearby basins that drain the Blue Mountains of northeast Oregon (Walla Walla and Grande Ronde basins). Adults from these releases must pass the Umatilla River near the middle or end of their upstream spawning migration. The average percent of strays in the Umatilla River run over the past ten years is well under the 10% maximum guideline outlined in Oregon's Wild Fish Policy (ODFW 1992) but is greater than the 5% goal currently advocated by some biologists (Grant 1997).

Fishery

The UFH program has been successful at providing a steelhead fishery on the Umatilla River. Estimated hours fished has remained between 4,500 and 6,700 since creel surveys were initiated in 1992. Regulation changes implemented in fall 1994 that opened the season three months earlier and extended it one month later expanded angler participation considerably. Numbers of anglers interviewed in our surveys nearly doubled from about 550 to 1,000 when anglers were allowed to fish the lower river in the fall. The Umatilla River steelhead fishery is comparable to those in the nearby Walla-Walla and Touchet rivers in terms of harvest and catch rate (Schuck et al. 1995, 1997) but much smaller than the Grande Ronde basin fishery (Flesher et al. 1996). Estimated hours fished and harvest in the Grande Ronde fishery is typically about five times greater than in the Umatilla River.

Our creel survey likely underestimated steelhead catch and harvest on the Umatilla River and should be viewed as an index for documenting long term trends. Harvest estimated from punch-card data has been two to five times higher than our creel estimates. Underestimation of harvest from creel survey data may indicate significant fishing activity in areas of the river that are not surveyed. Creel surveys are presently restricted to areas of the river that have easy public access, receive high angling pressure, and can be effectively surveyed. Although periodic checks in the unsurveyed area from TMFD to Barnhart Bluffs have consistently documented light fishing pressure, accurate pressure counts are difficult due to poor access. There are some indications harvest in this area may be disproportionately high. Radio telemetry studies indicate steelhead spend roughly three times longer in the unsurveyed river from TMFD to Stanfield Dam than in the area above Stanfield Dam which is mostly surveyed (Contor et al. 1997). Several reports of exceptionally successful drift boat trips through the unsurveyed area have been reported to local ODFW district and research personnel. Aerial surveys at key times should be considered to more accurately estimate the amount and distribution of angling effort in the unsurveyed river. This information may be useful for developing methods to monitor angling effort and catch rates in this area.

Table 35. Egg-take and survival of summer steelhead reared at Umatilla Hatchery, brood years 1991-1997. Eggs are from the Umatilla River.

Brood year	Number of eggs taken or received	Egg-to-fry survival (%)[ab]	Egg-to-smolt survival (%)[ab]
1991	340,674	78.5	77.7
1992	476,871	81.4	73.0
1993	255,441	85.7	86.0
1994	234,436	85.1	82.4
1995	223,525	86.8	76.6
1996	215,408	81.6	71.4
1997	209,639	82.4	76.3

[a] *Survival estimate is based on green egg-to-fry or smolt stage.*

[b] *Adjusted for eggs or fish that were destroyed, distributed to STEP program, or graded and removed.*

Table 36. Rearing conditions immediately before transfer for summer steelhead in Michigan raceways at Umatilla Hatchery and in Oregon raceways at Irrigon Hatchery, brood years 1991-1997.

Brood year	System	Maximum density (lb/ft^3)	Maximum loading (lb/gal/min)
1991	Michigan	5.4-6.7	11.8-14.6
1991	Oregon	1.3	6.6
1992	Michigan	4.0-4.5	8.9-9.9
1992	Oregon	1.3	6.6
1993	Michigan	3.8-4.6	8.4-10.1
1993	Oregon	1.4-1.5	6.7-7.4
1994	Michigan	4.0-4.2	9.7-10.2
1994	Oregon	1.3-1.4	7.3-10.4
1995	Michigan	4.1-4.3	9.8-10.4
1995	Oregon	1.2-1.4	5.9-6.9
1996	Michigan	3.4-3.9	8.1-9.3
1996	Oregon	1.3-1.5	7.1-8.0
1997	Michigan	3.7-3.8	8.7-9.1
1997	Oregon	1.3-1.5	7.1-8.0

Table 37. Water quality comparisons between first, second, and third pass Michigan raceways used to rear steelhead during 1997-98. Sampling period was November 1 to April 11.

		Mean parameter value				
Parameter measured	N	A pass	N	B pass	N	C pass
Temperature head (°C)	25	12.4	20	12.5	20	12.4
Temperature tail (°C)	25	12.3	20	12.5	20	12.4
pH head	25	7.5	20	7.6	20	7.6
pH tail	25	7.5	20	7.6	20	7.6
Oxygen head (ppm)	22	10.8	17	11.1	17	11.5
Oxygen tail (ppm)	22	8.3	17	8.0	17	8.7
Nitrogen head (mmHg)	22	606	17	602	17	593
Nitrogen tail (mmHg)	22	624	17	623	17	615
Total pressure-head (mmHg)	22	763	17	764	17	759
Total pressure-tail (mmHg)	22	746	17	742	17	744
Unionized ammonia (µg/l)	10	0.94	9	2.16	9	2.99
Alkalinity (mg/l $CaCO_3$)	5	139	5	144	5	144

Table 38. Mean length, weight, and condition factor for steelhead reared in Michigan and Oregon raceways at Umatilla Hatchery in 1997-98, 1997 brood.

		Length(mm)		Weight(g)		Condition Factor	
Sample	Pass	N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
				Oregon			
August:	A	97	55.8(0.6)	57	2.1(0.1)	57	1.19(0.02)
September:	A	108	78.4(0.8)	58	5.8(0.2)	58	1.16(0.01)
				Michigan			
October:	A	111	91.6(0.9)	51	8.8(0.4)	51	1.12(0.01)
	B	105	108.4(1.5)	45	15.1(0.7)	45	1.18(0.01)
	C	102	103.6(1.2)	47	14.2(0.8)	47	1.18(0.01)
November:	A	113	101.5(1.3)	55	13.9(0.6)	55	1.28(0.01)
	B	103	128.2(1.4)	53	26.1(1.4)	53	1.23(0.01)
	C	101	122.0(1.4)	58	24.3(1.0)	58	1.24(0.01)
December:	A	114	123.7(1.6)	58	23.8(1.3)	58	1.15(0.01)
	B	140	154.6(1.5)	54	43.3(2.1)	54	1.17(0.01)
	C	109	158.6(1.6)	51	50.2(2.2)	51	1.22(0.01)
January:	A	122	139.6(1.9)	52	30.8(2.0)	52	1.10(0.01)
	B	112	168.8(1.8)	48	54.5(2.5)	48	1.10(0.01)
	C	112	176.5(1.6)	53	63.8(2.6)	53	1.11(0.01)
February:	A	111	157.9(2.1)	51	45.9(2.8)	51	1.15(0.01)
	B	97	188.1(1.9)	48	75.6(3.1)	48	1.11(0.01)
	C	99	187.6(1.8)	48	76.9(3.4)	48	1.09(0.01)
March:	A	111	157.9(2.1)	51	45.9(2.8)	51	1.15(0.0)
Release[a]:	A	255	187.0(1.7)	106	71.9(2.9)	106	1.04(0.01)
	B	302	209.3(1.7)	208	95.5(3.1)	208	1.01(0.01)
	C	289	202.3(1.3)	198	77.0(1.7)	198	0.94(0.00)

[a] *Steelhead in A and C pass were acclimated and released at Bonifer Springs, steelhead in B pass were acclimated and released at Minthorn Springs.*

Table 39. Mean length, weight, and condition factor at release for summer steelhead reared in first, second, and third pass Michigan raceways at Umatilla Hatchery, 1991-97 broods (standard error in parentheses).

Brood year	Pass	Length (mm)	Weight (g)	Condition factor
1991	A	194.3(1.4)	91.0(3.2)	1.13(0.01)
	B	200.0(1.1)	90.2(2.4)	1.09(0.01)
	C	186.9(1.0)	76.7(2.1)	1.12(0.01)
1992	A	199.6(1.1)	74.8(2.1)	0.93(0.01)
`	B	198.2(1.2)	80.9(2.7)	1.01(0.01)
	C	220.1(1.0)	102.4(2.5)	0.93(0.01)
1993	A	205.9(1.2)	86.7(2.5)	0.97(0.01)
	B	198.3(1.2)	88.7(2.4)	1.05(0.01)
	C	214.2(1.1)	93.3(2.3)	0.94(0.01)
1994	A	206.3(1.1)	82.6(2.2)	0.90(0.01)
	B	209.7(1.0)	96.2(2.7)	1.00(0.01)
	C	205.9(0.8)	81.4(1.8)	0.90(0.01)
1995	A	207.9(1.1)	87.3(2.4)	0.99(0.01)
	B	206.8(1.3)	89.9(2.9)	0.98(0.01)
	C[a]	196.5(1.7)	85.4(3.2)	1.11(0.01)
1996	A	208.3(1.0)	93.3(2.3)	1.00(0.01)
	B	208.1(0.9)	99.5(1.5)	1.08(0.00)
	C	203.5(1.1)	84.8(1.7)	0.95(0.00)
1997	A	187.0(1.7)	71.9(2.9)	1.04(0.01)
	B	209.3(1.7)	95.5(3.1)	1.01(0.01)
	C	202.3(1.3)	77.0(1.7)	0.94(0.00)

[a] *The 1995 brood steelhead from pond M8C escaped from the acclimation pond prior to sampling. Measurements reported are from fish sampled at Umatilla Hatchery, approximately two weeks prior to transfer to acclimation ponds.*

Table 40. Mean proportion of descaled, partially descaled, and undamaged steelhead reared in Michigan passes at Umatilla Hatchery, brood years 1991-97.

Brood year	Pass	Descaled[a]	Partially Descaled[b]	Undamaged[c]
1991	A	0.01	0.43	0.56
1991	B	0.05	0.39	0.61
1991[d]	C			
1992	A	0.08	0.30	0.62
1992	B	0.03	0.56	0.41
1992	C	0.02	0.58	0.40
1993	A	0.05	0.13	0.82
1993	B	0.01	0.50	0.49
1993	C	0.11	0.33	0.56
1994	A	0.13	0.39	0.48
1994	B	0.00	0.21	0.79
1994	C	0.09	0.42	0.50
1995	A	0.03	0.70	0.28
1995	B	0.01	0.31	0.69
1995[e]	C			
1996	A	0.12	0.48	0.41
1996	B	0.02	0.35	0.63
1996	C	0.32	0.57	0.11
1997	A	0.00	0.04	0.96
1997	B	0.04	0.32	0.64
1997	C	0.05	0.34	0.61

[a] *More than 0.20 descaling on either side of the fish.*

[b] *Descaling = 0.03 to 0.20 on either side of the fish.*

[c] *Less than 0.03 descaling on either side of the fish.*

[d] *Data not available.*

[e] *The 1995 brood steelhead from pond M8C escaped from the acclimation pond prior to sampling.*

Table 41. Tag and mark information for steelhead reared at Umatilla hatchery and released in the Umatilla River in 1998, 1997 brood (CWT = coded wire tag, AD = adipose fin and LV = left ventral fin).

Raceway	Release date[a]	CWT code	Number CWT[b]	Fin clip	Number PIT-tagged fish released[c]	PIT-tags extruded after 48 h (%)	PIT-tag mortalities after 48 h (%)	Total number released
M8A	May 4	092339	21,292	ADLV	242	3.1	0.0	47,313
M8B	April 16	092341	21,210	ADLV	244	4.3	0.0	49,084
M8C	April 16	092340	21,282	ADLV	250	1.6	2.0	41,088

[a] *M8B-fish were released from Minthorn acclimation facility over a two day period beginning on 041698. Volitional release of M8C-fish began one week prior to forced release on 040598.*
[b] *Number recognizably coded-wire-tagged and released. All CWT fish were left ventral fin clipped and all fish received an adipose fin clip.*
[c] *PIT-tag files for raceways M8A, M8B, and M8C were WAC98097.M8A, WAC98064.M8B, and WAC98064.M8C, respectively.*

Table 42. Number and percent detected, median travel time, and median detection date at John Day and Bonneville dams for PIT-tagged steelhead released in the Umatilla River, spring 1998, 1997 brood.

		John Day			Bonneville		
Raceway	CWT code	Percent detected (number)	Median travel time (d)	Median detection date	Percent detected (number)[a]	Median travel time (d)	Median detection date
M8A	092339	8.7(21)	19	May 23	4.5(11)	20	May 24
M8B	092340	18.0(44)	35	May 21	9.8(24)	29	May 15
M8C[b]	092341	17.6(44)	35	May 21	8.0(20)	34	May 20

[a] *Percent and number of fish detected also includes 3, 5, and 4 fish also detected at John Day Dam for raceways M8A, M8B, and M8C, respectively.*
[b] *Travel time was based on forced release date.*

Table 43. Recovery data for branded, paint marked, and PIT-tagged steelhead reared in A, B, and C pass Michigan raceways at Umatilla Hatchery, released in the Umatilla River, and recaptured or detected at John Day Dam, brood years 1992-97 (number of observed recoveries in parentheses).

Brood Year	Mark[a]	Estimated passage[a] (%) M8A	M8B	M8C
1993	Brand	3.3 (20)	28.7 (191)	19.4 (119)
1994	Brand	8.9 (53)	8.4 (51)	3.7 (22)
1995	Brand	2.0 (6)	3.0 (4)	2.0 (3)
1996	Brand	0.0 (0)	0.0 (0)	0.8 (1)
1997	Paint	(3)	[b]	[b]
		Percent detected[c]		
1998	PIT tag	8.7 (21)	18.0 (44)	17.6 (44)

[a] *Brand recoveries from 1993-1997 were expanded by sampling and collection efficiency to estimate passage.*
[b] *No fish were paint-marked.*
[c] *PIT-tag detections in 1998 are not expanded for bypass collection efficiency. PIT-tag detection (sampling) efficiency was 100% in 1998.*

Table 44. Mean fork length at tagging of PIT-tagged steelhead released in the Umatilla River and detected at John Day and Bonneville dams, spring 1998.

	Length at tagging			Length at tagging of detected fish			
Raceway	Mean (mm)	SD	N	Mean (mm)	SD	N	P
M8A	186.7	27	242	195.2	19	30	0.01
M8B	185.4	20	255	189.4	15	64	0.02
M8C	194.1	20	254	199.8	18	60	0.01

Table 45. Exploitation and survival of steelhead reared at Umatilla Hatchery, coded-wire-tagged (CWT) and released in the Umatilla River, 1991-93 broods. Recoveries are complete for the 1991-93 broods, other broods data is incomplete. Estimates of number of adults recovered are based on total production in each raceway. Data was downloaded in January 1999.

Brood year, CWT code	Raceway	N[a]	Total exploi-tation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of adults recovered
1991						
075838	M5A	1	0.0	0.01	0.01	2
075839	M5A	1	0.0	0.01	0.01	2
075840	M5A	1	0.0	0.01	0.01	2
075841	M5B	2	100.0	0.00	0.02	4
075842	M5B	0	0.0	0.00	0.00	0
075843	M5B	4	100.0	0.00	0.04	9
074127	M5C	27	0.0	0.26	0.26	58
073862	M5C	14	42.9	0.08	0.13	30
073759	M5C	23	52.2	0.11	0.22	50
Total/Average		73	32.9	0.05	0.08	157
1992						
076052	M5A	8	0.0	0.06	0.06	13
076053	M5A	11	0.0	0.10	0.10	21
076054	M5A	8	0.0	0.08	0.08	18
076055	M5B	56	1.8	0.54	0.58	92
076056	M5B	56	30.4	0.41	0.60	95
076057	M5B	59	11.9	0.54	0.61	98
076058	M5C	70	18.6	0.56	0.69	103
076059	M5C	42	9.5	0.39	0.43	64
076060	M5C	74	18.9	0.64	0.78	117
Total/Average		384	10.1	0.37	0.43	621
1993						
070139	M5A	5	20.0	0.05	0.06	15
070140	M5A	1	0.0	0.01	0.01	3
070141	M5B	36	13.9	0.31	0.36	89
070142	M5B	62	45.2	0.34	0.62	155
070143	M5C	44	34.1	0.28	0.42	111
070144	M5C	63	11.1	0.58	0.65	163
Total/Average		211	20.7	0.26	0.35	536

[a] *Expanded CWT recoveries*

Table 45. (continued)

Brood year, CWT code	Raceway	N[a]	Total exploi-tation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number adults recovered
1994						
070655	M5A	41	3.7	0.17	0.21	101
070656	M5B	207	12.7	0.72	1.10	550
070657	M5C	206	13.4	0.82	1.07	519
Total/Average		454	9.9	0.56	0.79	1,170
1995						
071034	M8A	7	0.0	0.03	0.03	17
071035	M8B	82	6.1	0.39	0.42	197
071036	M8C	37	16.2	0.15	0.17	86
Total/Average		126	7.4	0.19	0.21	300

Table 46. Number of steelhead that returned to the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1997-98.

Origin[a]	Male		Female		Unknown		Total	
Age	Number	%	Number	%	Number	%	Number	%
Hatchery	373	41.3	530	58.7	0	0.0	903	51.2
Wild	269	31.2	593	68.8	0	0.0	862	48.8
Total	642	36.4	1,123	63.6	0	0.0	1,765	100.0

[a] *Origin determined by presence or absence of adipose fish. Thirteen hatchery fish were strays based on coded-wire tags (unexpanded).*

Table 47. Vital statistics of wild (unmarked) and hatchery steelhead that returned to the east-bank fish ladder at Three Mile Falls Dam, Umatilla River, 1997-98. Data for hatchery fish was determined from coded-wire tag recovery of Umatilla origin fish. Age of wild fish was determined from scale analysis (personal communication, P. Kissner, CTUIR, Pendleton, OR). Sex was determined visually.

				Fork length (mm)		
Brood year	Age	Number	Sex	mean	min	max
			Wild			
1992	2.3	1	female		725	
	4.1	1	female		615	
1993	2.2	5	male	703	635	760
	2.2	8	female	697	505	771
	3.1	2	male	656	655	656
	3.1	2	female	595	584	605
1994	2.1	13	male	612	554	700
	2.1	19	female	584	445	670
	1.2	1	female		559	
1995	1.1	1	female		559	
			Hatchery			
1994	1.2	12	male	769	685	825
1994	1.2	29	female	736	670	800
1995	1.1	23	male	611	561	655
1995	1.1	10	female	595	545	650

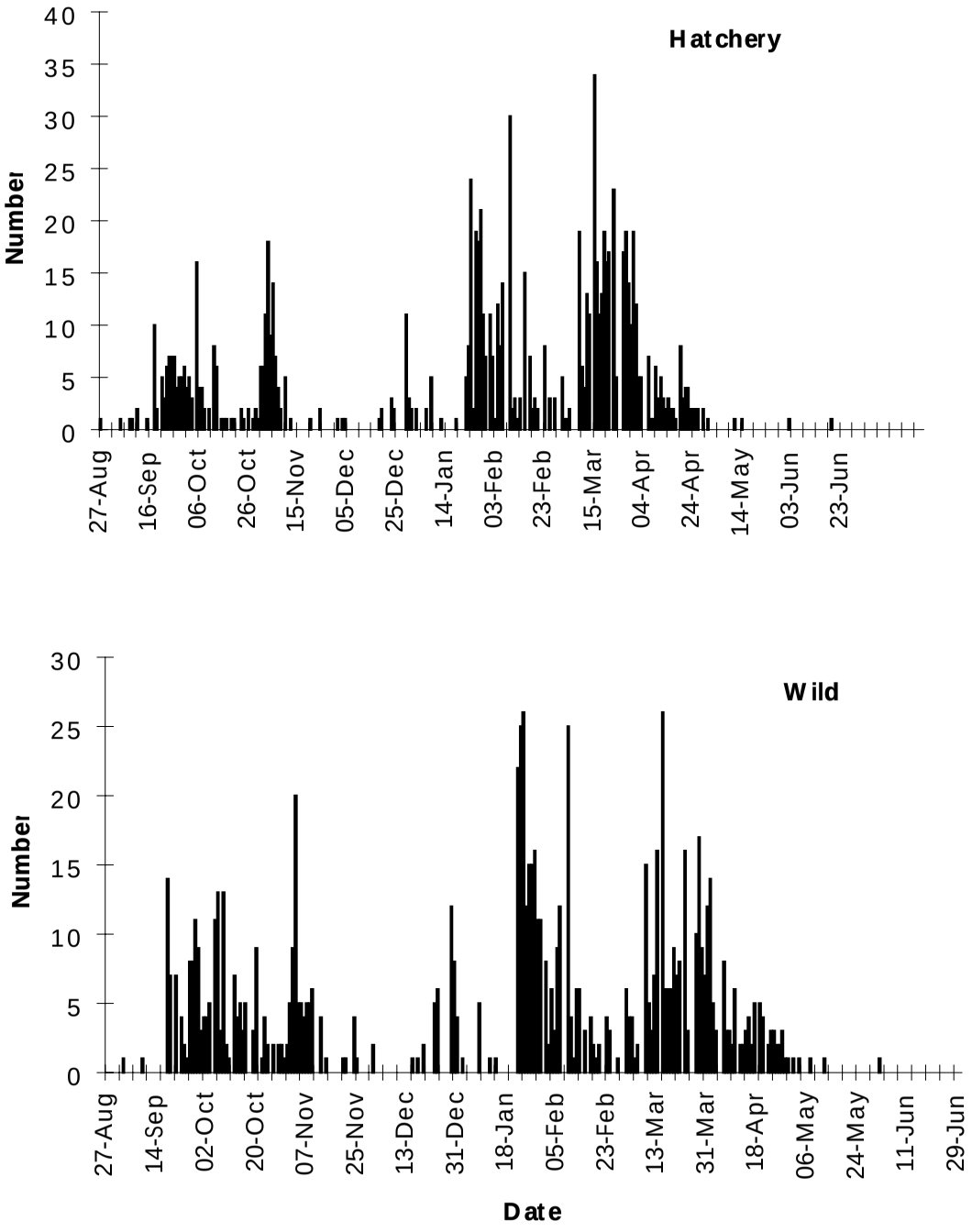

Figure 4. Numbers of wild and hatchery steelhead counted at the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1997-98.

Table 48. Estimated catch statistics for steelhead in the Umatilla River in 1997-98. Lower river = Mouth of the Umatilla River to Three Mile Falls Dam. Upper River = Barnhart Bluffs to the lower boundary of the Confederated Tribes of the Umatilla Indian Reservation. Number caught and number harvested includes ± 95% confidence interval.

Month, Day type	Number sampled Days	Number sampled Anglers	Hours fished	Number caught	Number harvested	Catch rate (fish/h)
			Lower River			
September						
Weekday	5	13	290	0±11	0± 0	0.00
Weekend	5	16	361	22±38	22±38	0.06
Total	10	29	651	22±38	22±38	0.03
October						
Weekday	11	93	696	50+35	12±13	0.07
Weekend	8	124	518	26±16	21±14	0.05
Total	19	217	1,214	76±39	33±19	0.06
November						
Weekday	9	51	348	6±11	6±11	0.02
Weekend	11	137	529	27±11	8± 7	0.05
Total	20	188	877	33±15	14±13	0.04
December						
Weekday	5	9	89	15±27	7±14	0.16
Weekend	4	20	161	37±54	8±15	0.23
Total	9	29	250	52±61	15±20	0.21
January						
Weekday	4	8	128	20±40	0± 0	0.16
Weekend	4	19	204	9±18	5± 9	0.05
Total	8	27	332	29±43	5± 9	0.08
February						
Weekday	3	8	202	0± 0	0± 0	0.00
Weekend	3	17	201	0± 0	0± 0	0.00
Total	6	25	403	0± 0	0± 0	0.00
Lower river						
Total	72	515	3,727	212± 94	89±50	0.06

Table 48 (continued).

Month, Day type	Number sampled Days	Number sampled Anglers	Hours fished	Number caught	Number harvested	Catch rate (fish/h)
			Upper River			
November						
Weekday	0	0	0	0± 0	0± 0	0.00
Weekend	1	12	0	0± 0	0± 0	0.00
Total	1	12	0	0± 0	0± 0	0.00
December						
Weekday	7	8	81	0± 0	0± 0	0.00
Weekend	3	16	167	0± 0	0± 0	0.00
Total	10	24	248	0± 0	0± 0	0.00
January						
Weekday	2	3	86	12±23	0± 0	0.14
Weekend	3	22	225	5±10	0± 0	0.02
Total	5	25	311	17±25	0± 0	0.04
February						
Weekday	7	70	555	51±62	5± 9	0.09
Weekend	6	95	485	10± 9	3± 5	0.02
Total	13	165	1,040	61±62	8±11	0.05
March						
Weekday	4	30	543	64±46	0± 0	0.12
Weekend	6	76	441	24±22	4± 8	0.06
Total	10	106	984	88±50	4± 8	0.07
April						
Weekday	4	15	207	0± 0	0± 0	0.00
Weekend	4	36	159	4± 4	0± 0	0.03
Total	8	51	366	4± 4	0± 0	0.02
Upper river						
Total	46	371	2,949	170± 84	12±13	0.05
Grand						
Total	118	886	6,676	382±126	101±52	0.05

Table 49. Summary of steelhead catch statistics, 1992-98. Data is combined from lower river (Umatilla mouth to Three Mile Falls Dam) and upper river (Barnhart Bluffs to lower boundary of the Confederated Tribes of the Umatilla Indian reservation).

Year[a]	Number anglers	Hours fished	Number caught	Number harvested	Catch rate (fish/h)
1992-93	543	5,293	177	37	0.03
1993-94	577	4,504	63	19	0.02
1994-95	1,070	6,172	257	61	0.05
1995-96	880	4,560	232	60	0.06
1996-97	1,356	5,931	294	90	0.04
1997-98	886	6,676	382	101	0.05

[a] *Angling season in 1992-93 and 1993-94 was from December 1 to March 15. Beginning in 1994-95 the angling season was from September 1 to April 15.*

Table 50. Descriptive statistics for the steelhead fishery in the Umatilla River, run years 1993-94 through 1997-98. Catch statistics were based on creel surveys conducted in the lower river (Umatilla mouth to Three Mile Falls Dam) and upper river (Barnhart Bluffs to lower boundary of the CTUIR).

Statistic	Fish origin or creel area[a]	Run year 93-94	94-95	95-96	96-97	97-98	Mean
Run size	WSTS	945	875	1296	1014	862	998
	HSTS	359	696	819	1529	994	879
Run composition (%)[b]	WSTS	72	56	61	40	46	55
	HSTS	28	44	39	60	54	45
Catch composition (%)	WSTS	59	67	70	59	62	63
	HSTS	41	33	30	41	38	37
Number caught	WSTS	37	172	161	168	239	155
	HSTS	26	85	69	115	146	88
Percent of run caught	WSTS	4	20	12	17	28	16
	HSTS	7	12	8	8	15	10
Percent of run harvested	HSTS	5.3	8.7	7.3	5.9	10.4	7.5
Composition of lower river catch (%)	WSTS	49	67	64	59	49	58
	HSTS	51	33	36	41	51	42
Composition of upper river catch (%)	WSTS	71	66	75	60	78	70
	HSTS	29	34	25	40	22	30
Location of WSTS catch (%)	Lower Rr.	46	70	44	71	44	55
	Upper Rr.	54	30	56	29	56	45
Location of HSTS catch (%)	Lower Rr.	69	68	56	72	74	68
	Upper Rr.	31	32	44	28	26	32
Percent of WSTS run caught	Lower Rr.	1.8	13.7	5.4	11.9	12.2	9.0
	Upper Rr.	2.1	5.9	7.0	4.7	15.5	7.1
Percent of HSTS run caught	Lower Rr.	5.0	8.3	4.7	5.4	10.9	6.9
	Upper Rr.	2.2	3.9	3.7	2.1	3.8	3.1
Percent of HSTS run harvested	Lower Rr.	3.9	5.7	4.2	4.3	9.2	5.5
	Upper Rr.	1.4	3.0	3.1	1.6	1.2	2.0

[a] *WSTS = wild steelhead; HSTS = hatchery steelhead; Lower Rr. = lower river creel area; Upper Rr. = upper river creel area.*

[b] *Hatchery steelhead run = number counted at Three Mile Falls Dam plus harvest below Three Mile Falls Dam; Wild steelhead run = number counted at Three Mile Falls Dam.*

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APPENDIX TABLES

Appendix Table A-1. Release information for salmonids reared at Umatilla, Bonneville, Little White Salmon, Carson, and Willard hatcheries and released into the Umatilla River in 1998 (Acclimation sites: BS=Bonifer Springs, IC = Imeques-c-mem-ini-kem,; MI=Minthorn acclimation site; TH = Thornhollow).

Race-species, release strategy, system	Brood year	Date released	Number released	Mean fork length (mm)	Mean weight (g)	Accli-mation (days)	Release location
Umatilla Hatchery							
Fall chinook salmon							
Subyearlings	1997						
Michigan		May 28 & June 1 1998	2,777,442	85.3	6.8	17-18	IC/TH
Spring chinook salmon							
Yearlings	1996						
Oregon		March 8, 1998	226,840	148.7	38.9	27	IC
Michigan		March 8, 1998	155,874			27	IC
			382,714				
Summer steelhead	1996						
Michigan		May 5, 1998	47,313	187.0	71.9	14	BS
Michigan		April 13, 1998	49,084	209.3	95.5	29	MI
Michigan		April 16, 1998	41,088	202.3	77.0	28	BS
Total			137,485				
Bonneville Hatchery							
Fall chinook salmon							
Yearlings	1996						
Oregon		March 13 1998	256,910	149.4	41.9	16	TH
Willard Hatchery							
Fall chinook salmon							
Yearlings	1996						
Oregon		April 17, 1998	179,100	172.2	58.5	31	TH
Carson Hatchery							
Spring chinook salmon							
Yearlings	1996						
Oregon		April 14, 1998	99,641	134.0	27.9	33	IC
Little White Salmon Hatchery							
Spring chinook salmon							
Yearlings	1996						
		March 8, 1998	172,999	135.5	29.0	18	IC
		April 14, 1998	172,258	149.1	39.5	34	IC
Total			345,257				

Appendix Table A-2. Release data for subyearling fall chinook salmon reared at Umatilla Hatchery and released in the Umatilla River (RM= river mile, TH=Thornhollow acclimation facility, RM 73.5; IC=Imeques-C-mem-ini-kem acclimation facility, RM 80).

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT tag[b]	Fish per pound	Release location (RM)
1991							
071433	05/18/92	M2A	303,878	29,066	7,445	61.0	42.5
071434	05/18/92	M3A	306,802	31,224	6,917	65.7	42.5
071435	05/18/92	M2B	297,331	30,326	9,643	60.9	42.5
071436	05/18/92	M3B	302,555	30,365	7,049	61.9	42.5
071437	05/18/92	M2C	223,830	30,508	7,526	55.2	42.5
071438	05/18/92	M3C	301,831	30,924	7,656	64.5	42.5
subtotal			1,736,227	182,413	46,236	61.8	
071430	05/19/92	O2A	281,350	32,287	9,174	65.1	42.5
071429	05/20/92	O3A	286,578	31,892	6,272	70.6	42.5
071432	05/19/92	O2B	191,257	29,425	8,558	58.3	42.5
071431	05/19/92	O3B	182,931	28,951	8,863	56.2	42.5
subtotal			942,116	122,555	32,867	63.7	
Total			2,680,343	304,968	79,103	62.5	
1992							
076330	05/24/93	M2A	292,895	28,964	10,027	63.0	73.5
076331	05/24/93	M3A	282,125	29,537	10,053	67.0	73.5
070127	05/24/93	M2B	269,336	27,092	10,150	63.4	73.5
076333	05/24/93	M3B	273,662	29,718	10,020	60.3	73.5
076334	05/24/93	M2C	282,175	29,958	9,434	68.0	73.5
076332	05/24/93	M3C	277,931	29,451	9,894	61.5	73.5
subtotal			1,678,124	174,720	59,578	63.9	
070126	05/25/93	O2A	268,001	29,594	10,458	59.3	73.5
070125	05/25/93	O3A	272,496	29,360	9,828	59.4	73.5
076329	05/25/93	O2B	203,731	30,706	10,278	59.4	73.5
076335	05/25/93	O3B	207,565	30,462	10,547	59.4	73.5
subtotal			951,793	120,122	41,173	59.4	
Total			2,629,917	294,842	101,361	62.3	
1993							
070663	0523/94	M2A	322,867	31,162	10,171	63.0	73.5
070719	05/23/94	M3A	327,700	31,658	9,725	72.4	73.5
070720	05/23/94	M2B	314,518	30,528	10,008	65.4	73.5
070723	05/23/94	M3B	326,408	30,447	10,217	68.2	73.5
070722	05/23/94	M2C	303,843	30,950	9,769	68.0	73.5
070721	05/23/94	M3C	306,105	28,474	9,373	68.7	73.5
subtotal			1,901,441	183,219	59,263	67.6	

[a] *All fish were RV fin clipped and all coded-wire tagged fish were adipose fin clipped. Beginning with the 1993 brood, all non coded-wire tagged fish were tagged with blank-wire.*

[b] *Fish from 1991-95 broods were branded.*

Appendix Table A-2 (continued)

Brood year, CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT tag[b]	Fish per pound	Release location (RM)
1993							
070662	05/24/94	O2A	280,046	31,239	10,158	60.1	73.5
070718	05/24/94	O3A	279,965	31,040	10,220	64.2	73.5
070716	05/24/94	O2B	191,321	30,502	10,906	59.1	73.5
070717	05/24/94	O3B	190,439	32,481	10,260	60.0	73.5
subtotal			941,771	125,262	41,544	61.1	
Total			2,843,212	308,481	103,331	65.5	
1994							
071019	05/31/95	M2A	286,459	29,353	10,665	62.7	IC
071017	05/31/95	M3A	271,129	29,736	10,172	67.8	IC
071022	05/31/95	M2B	280,406	28,472	10,323	63.0	IC
071020	05/31/95	M3B	275,613	29,460	10,183	65.6	IC
071025	05/31/95	M2C	274,110	29,784	10,176	66.5	TH
071023	05/31/95	M3C	287,313	28,623	10,249	63.0	TH
subtotal			1,675,030	175,428	61,768	64.7	
071026	05/31/95	O1A	245,885	30,106	10,374	58.0	IC
071018	05/31/95	O3A	241,342	29,132	10,438	65.1	IC
071024	05/31/95	O1B	151,943	30,204	10,248	62.3	IC
071021	05/31/95	O3B	152,098	29,327	11,104	58.7	IC
subtotal			791,268	118,769	42,167	61.1	
Total			2,466,298	294,197	103,946	63.6	
1995							
071320	05/30/96	M2A	303,803	30,015	10,557	69.5	IC
071321	05/30/96	M3A	299,233	28,997	9,407	68.4	IC
071323	05/30/96	M2B	300,377	29,914	9,965	62.8	IC
071325	05/30/96	M3B	300,895	30,220	10,389	67.4	IC
071157	05/31/96	M2C	393,339	29,852	10,316	72.8	TH
071327	05/31/96	M3C	460,259	28,476	10,378	69.5	TH
	05/31/96	M4C	251,582			66.3	TH
subtotal			2,309,488	177,474	61,012	68.4	
071322	05/30/96	O2A	266,913	29,646	10,252	57.2	IC
071324	05/30/96	O3A	272,594	30,243	10,420	66.4	IC
071326	05/30/96	O2B	181,291	30,238	10,237	56.5	IC
071328	05/30/96	O3B	181,709	30,455	9,980	60.3	IC
subtotal			902,507	120,582	40,889	60.5	
Total			3,211,995	298,056	101,901	66.2	

Appendix Table 2 (continued)

Brood year CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT tag[a]	Fish per pound	Release location (RM)
1996							
092129	05/30/97	M1A	294,417	33,161	8,469	63.6	IC/TH
092130	05/30/97	M1B	294,043	32,464		62.4	IC/TH
092132	05/29/97	M1C	304,993	31,382		66.8	IC
092131	05/30/97	M2A	395,493	31,844	8,094	67.9	IC/TH
092133	05/29/97	M2B	394,250	33,273		70.7	IC
092134	05/29/97	M2C	311,016	33,640		67.6	IC
092126	05/30/97	M4A	197,028	33,555	9,000	67.2	TH
092127	05/29/97	M4B	195,031	32,764		70.2	IC
092128	05/29/97	M4C	194,562	29,732		65.6	IC
Total			2,580,833	291,815	27,238	67.0	
1997							
092404	05/28/98	M2A	214,521	33,286	520	65.2	TH
092407	06/01/98	M2B	202,816	33,661	505	66.3	TH
092410	06/01/98	M2C	215,643	31,820	508	66.7	IC
092403	05/28/98	M3A	305,038	30,808	493	65.5	TH
092406	06/01/98	M3B	317,296	30,558	510	67.3	IC
092409	06/01/98	M3C	302,336	32,219	509	67.1	IC
092402	05/28/98	M4A	400,614	30,654	504	64.1	TH
092405	05/28/98	M4B	413,832	30,533	507	67.2	IC
092408	05/28/98	M4C	405,346	32,322	508	69.8	IC
Total			2,777,442	284,861	4,564	66.7	

[a] *Fish from 1996 brood were paint marked on the anal fin, 1997 brood was PIT-tagged.*

Appendix Table A-3. Release data for yearling fall chinook salmon reared at Bonneville, Umatilla and Willard hatcheries and released in the Umatilla River (RM= river mile, TH=Thornhollow acclimation facility, RM 73.5).

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT tag[b]	Fish per pound	Release location (RM)
			Bonneville Hatchery				
1990							
075619	03/19/92	A8	122,639	26,160		7.5	56.0
075618	03/17/92	A9	97,801	26,178		7.5	70.0
Total			220,440	52,338		7.7	
1991							
071461	03/18/93	A5	66,345	23,239		8.7	73.5
071460	03/18/93	A6	68,492	23,863		9.1	73.5
Total			134,837	47,102		8.9	
1992							
070252	04/19/94	A5	49,824	23,470		8.5	73.5
070255	03/23/94	A6	233,629	23,699		10.4	73.5
Total			283,453	47,169		9.5	
1993							
070658	04/07/95	A2	111,817	24,865		7.8	TH
070659	04/07/95	A5	115,271	24,374		8.2	TH
Total			227,088	49,239		8.0	
1994							
071037	04/05/96	A4	204,022	27,397	5,218	7.0	TH
071038	04/18/96	A3	217,294	28,521	5,111	7.0	IM
Total			421,316	55,918	10,329	7.0	
1996							
092037	03/13/98	A11	256,910	27,402	252	10.8	TH

[a] *All fish were RV fin clipped and all coded-wire tagged fish were adipose fin clipped. Beginning with the 1992 brood, all non coded-wire tagged fish were tagged with blank-wire.*
[b a] *Fish from 1994 brood were branded, 1996 brood was PIT tagged.*

(Appendix Table A-3,(continued)

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT tag[b]	Fish per pound	Release location (RM)
			Umatilla Hatchery				
1994							
071039	04/18/96	M3A	48,499	23,238	5,197	5.3	IM
071040	04/18/96	M3B	47,463	23,442	5,449	4.7	IM
071041	04/18/96	M3C	47,125	23,343	5,313	5.3	IM
Total			143,087	70,023	15,959	5.1	
1995[b]							
091729	03/25/97	O3A	53,993	25,250	4,180	7.6	IM/TH
091748	03/25/97	O3B	51,917	25,260	4,798	7.6	IM
subtotal			105,910	50,510	4,180	7.6	
071358	03/25/97	M1A	51,112	25,983		8.2	TH
091807	03/25/97	M1B	51,066	25,258		8.2	TH
071359	03/25/97	M1C	50,865	25,232		8.1	TH
subtotal			153,043	76,473	4,798	8.2	
Total			258,953	126,983	8,978	7.9	
			Willard				
1995							
070953	03/30/97	45	169,478	29,983		13.7	TH
070954	03/30/97	46	91,490	30,344		13.4	TH
Total			260,968	60,327		13.6	
1996							
071158	04/17/98	41	89,106	21,547	255	7.8	TH
076127	04/17/98	42	89,994	22,783	258	7.8	TH
Total			179,100	44,330	513	7.8	

[b] *The 1994 brood was branded. The 1995 brood was paint marked 4,180 fish were paint marked red on the anal fin and represent codes 091729, 071359 , and 091807; 4,798 fish were paint marked orange and represent codes 091729 and 091748. The 1996 brood was PIT tagged.*

Appendix Table A-4. Release data for subyearling spring chinook salmon reared at Umatilla Hatchery and released in the Umatilla River (RM= river mile)

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
1991							
071443	05/13/92	O4A	97,013	50,611	8,392	32.1	80
071444	05/12/92	O4B	63,585	48,051	8,384	31.2	80
071445	05/12/92	O5B	63,305	49,498	6,572	32.2	80
071446	05/13/92	O5A	95,456	50,045	8,195	32.1	80
subtotal			319,359	198,205	31,544	31.9	
071447	05/12/92	M6A	104,670	50,047	9,877	36.4	80
071448	05/12/92	M7A	104,929	51,707	9,903	36.3	80
071449	05/11/92	M6B	109,528	51,518	10,442	38.3	80
071450	05/12/92	M7B	109,997	51,271	9,816	37.8	80
071451	05/11/92	M6C	98,617	52,128	10,148	39.2	80
071452	05/11/92	M7C	108,652	51,659	9,609	36.8	80
subtotal			636,393	308,330	59,256	37.5	
Total			955,752	506,535	90,800	35.6	
1992							
076132	06/01/93	M6C	113,852	52,893	10,033	28.4	80
076133	06/01/93	M7C	116,316	52,335	10,372	27.7	80
076134	06/01/93	M7B	111,333	51,963	10,139	27.9	80
076135	06/01/93	M6B	109,473	51,680	9,961	28.2	80
076136	06/02/93	M6A	105,290	52,588	9,127	28.6	80
076137	06/02/93	M7A	111,103	52,172	9,137	26.9	80
Total			667,367	313,631	58,929	27.6	
1993							
070734	05/20/94	M6A	140,255	49,726	8,889	30.7	80
070735	05/20/94	M7A	142,237	52,298	9,217	30.7	80
070736	05/20/94	M6B	140,227	52,636	9,998	30.3	80
070737	05/20/94	M7B	142,003	53,172	10,182	30.3	80
070738	05/20/94	M6C	138,665	51,042	9,872	30.5	80
070739	05/20/94	M7C	135,990	52,317	9,925	30.5	80
Total			839,377	311,191	58,083	30.4	

[a] *All fish from even numbered brood years were LV fin clipped and fish from odd numbered brood years were RV fin clipped. All coded-wire tagged fish were adipose fin clipped.*
[b] *Fish from 1991-93 broods were branded.*

Appendix Table A-5. Release data for spring chinook salmon released in the fall. Fish were reared at Umatilla and Bonneville Hatcheries and released in the Umatilla River (IC - Imeques-C-mem-ini-kem acclimation facility).

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
Bonneville Hatchery							
1991							
076042	11/05/92	A11	25,104	25,104		13.0	80
076043	11/05/92	A10/11	25,075	24,992		13.0	80
076044	11/04/92	A10	15,730	15,423		13.1	80
076045	11/03/92	A9	24,638	24,638		9.9	80
076046	11/03/92	A8/9	24,715	24,221		10.0	80
076047	11/03/92	A8	17,667	17,269		10.1	80
Total			132,929	131,647		11.5	
Umatilla Hatchery							
1991							
071542	11/05/92	O3B	50,736	26,135		19.3	80
071543	11/05/92	O3A	50,680	25,633		19.5	80
Total			101,416	51,768		19.4	
1992							
070155	11/17/93	O2A	40,661	35,710		18.5	80
070156	11/17/93	O3A	42,734	33,999		18.8	80
070157	11/17/93	O2B	39,656	34,857		18.0	80
070158	11/17/93	O3B	41,244	34,130		19.2	80
subtotal			164,295	138,696		18.6	
070159	11/16/93	M2A	49,694	34,541		20.3	80
070160	11/17/93	M3A	49,081	35,408		20.9	80
070161	11/17/93	M2B	52,211	35,657		21.5	80
070162	11/16/93	M3B	48,343	35,467		20.2	80
070163	11/17/93	M3C	49,318	36,157		20.8	80
070216	11/16/93	M2C	47,867	36,102		20.8	80
subtotal			296,514	213,332		20.8	
Total			460,809	352,028		20.0	

[a] *All fish from even numbered brood years were LV fin clipped and fish from odd numbered brood years were RV fin clipped. All coded-wire tagged fish were adipose fin clipped.*

Appendix Table A-5 (continued)

Brood year, CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
1993							
070724	11/15/94	M2C	39,548	34,124		9.0	IC
070725	11/15/94	M3C	39,517	34,827		9.3	IC
070726	11/15/94	M2B	39,551	35,156		10.5	IC
070727	11/15/94	M3B	39,487	34,819		9.2	IC
070728	11/15/94	M2A	38,234	34,808		9.5	IC
070729	11/15/94	M3A	40,383	35,160		9.4	IC
subtotal			236,720	208,894		9.6	
070730	11/15/94	O2A	37,073	34,915		7.2	IC
070731	11/15/94	O1A	37,096	35,750		7.8	IC
070732	11/15/94	O2B	32,687	32,251		7.4	IC
070733	11/15/94	O1B	34,649	34,220		9.6	IC
subtotal			141,505	137,136		8.0	
Total			378,225	345,030		9.0	

Appendix Table A-6. Release data for yearling spring chinook salmon. Fish were reared at Bonneville, Umatilla, Little White Salmon, and Carson hatcheries and released in the Umatilla River (IC - Imeques-C-mem-ini-kem acclimation facility).

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
			Bonneville Hatchery				
1991							
071455	03/23/93	B1	92,728	19,951		14.8	80
071456	03/22/93	B2	94,220	20,022		14.3	80
Total			186,948	39,973		14.5	
1992							
070250	03/25/94	B6	99,616	26,716		11.7	80
070251	03/25/94	B5	101,830	26,305		11.7	80
075944	03/25/94	B8	103,980	20,109	4,818	12.5	80
075945	03/25/94	B7	99,676	20,219	5,200	12.2	80
Total			405,102	93,349	10,018	12.0	
1993							
070649	04/21/95	B7	123,257	22,189	5,137	10.5	80
070650	04/21/95	B8	124,614	24,088	4,878	10.2	80
070660	03/13/95	B5	74,735	23,607		13.9	80
070661	04/14/95	B6	74,921	28,765		11.4	80
Total			397,527	98,649	10,015	11.2	
			Umatilla Hatchery				
1991							
075739	03/23/93	O5B	50,312	21,499	5,300	8.2	80
075740	03/23/93	O4B	50,109	20,880	4,934	8.1	80
075741	03/24/93	O4A	54,347	21,157	5,548	8.3	80
075742	03/24/93	O5A	54,014	20,307	5,242	8.6	80
Total			208,782	83,843	21,085	8.3	
1992							
070217	03/21/94	O5A	51,210	20,070	5,082	8.5	80
070218	03/21/94	O5B	49,375	19,920	5,142	8.1	80
070219	03/21/94	O4B	52,620	20,971	5,151	8.8	80
070220	03/22/94	O4A	51,938	20,982	5,419	8.4	80
Total			205,143	81,943	20,797	8.5	

[a] *All fish from even numbered brood years were LV fin clipped and fish from odd numbered brood years were RV fin clipped. All coded-wire tagged fish were adipose fin clipped.*
[b] *Fish from 1991-93 broods were branded.*

Appendix Table A-6 (continued)

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
1993							
071453	03/13/95	M5A	50,007	20,315	4,910	8.3	80
071454	03/13/95	M5B	40,685	15,661	4,436	8.9	80
subtotal			90,692	35,976	10,015	7.8	
070651	03/13/95	O4A	49,001	18,864	5,176	9.1	80
070652	03/13/95	O4B	44,077	19,052	4,975	8.2	80
070653	03/13/95	O5B	44,188	18,175	5,133	9.0	80
070654	03/13/95	O5A	47,846	19,091	5,063	8.7	80
subtotal			185,112	75,182	20,347	8.0	
Total			275,804	111,158	29,673	7.9	
1994							
071027	03/13/96	M6A	49,032	19,622	5,083	9.0	IC
071028	03/13/96	M6B	45,887	18,844	4,682	10.8	IC
071029	03/13/96	M6C	49,121	19,258	5,275	9.0	IC
subtotal			144,040	57,724	15,040	9.6	
071030	03/13/96	O4A	60,599	19,961	4,531	7.5	IC
071031	03/13/96	O5A	60,137	20,066	5,026	8.8	IC
071032	03/13/96	O5B	57,076	19,874	5,092	8.7	IC
071033	03/13/96	O4B	56,709	19,583	4,232	9.5	IC
subtotal			234,521	79,484	18,881	8.6	
Total			378,561	137,208	33,921	9.0	
1995							
091730[a]	03/26/97	O4A	57,668	19,842	3,724	9.3	IC
091750	03/26/97	O4B	56,901	20,289		9.3	IC
091749	03/26/97	O5A	56,764	19,818		8.9	IC
091751	03/26/97	O5B	54,550	20,597		8.9	IC
Total			225,883	80,546		9.1	
1996							
092256	03/08/98	M2A	52,159	23,162	248	11.2	IC
092257	03/08/98	M2B	51,972	22,788	243	11.2	IC
092258	03/08/98	M2C	51,743	22,450	240	11.5	IC
subtotal			155,874	68,400	731	11.3	
092259	03/08/98	O5A	60,277	23,247	237	11.8	IC
092260	03/08/98	O4A	59,744	22,759	247	11.9	IC
092261	03/08/98	O5B	53,502	23,248	233	11.9	IC
092262	03/08/98	O4B	53,317	23,778	244	12.0	IC
subtotal			226,840	93,032	961	11.9	
Total			382,714	161,432	1,692	11.7	

Appendix Table A-6 (continued)

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
			Little White Salmon				
1996							
071420	03/08/98	39-40	172,999	19,403	235	15.6	IC
075743	04/14/98	34-38	172,258	19,255	244	11.6	IC
Total			345,257	38,658	479	13.6	
			Carson				
1996							
076036	04/14/98	37-40	99,641	18,721	241	16.3	IC

[a] *All fish from even numbered brood years were LV fin clipped and fish from odd numbered brood years were RV fin clipped. All coded-wire tagged fish were adipose fin clipped.*

[b] *Fish from 1991-94 broods were branded; 1995 brood was paint-marked (3,724) green on the anal fin. Mark represents tag codes 091730, 091750, and 091751; 1996 brood was PIT-tagged.*

Appendix Table A-7. Release data for summer steelhead reared at Umatilla Hatchery and released in the Umatilla River (RM= river mile; acclimation facilities: BS - Bonifer Springs acclimation facility, RM=63.5; MC - Meacham Creek; MI - Minthorn Springs acclimation facility, RM=68.5; TH - Thornhollow acclimation facility, RM=68.5)

Brood year, CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT-tag[a]	Fish per pound	Release location (RM)
1991							
075840	05/01/92	M5A	22,288	10,105		5.5	MC
075838	05/01/92	M5A	22,469	10,562		5.5	MC
075839	05/01/92	M5A	22,662	10,275		5.5	MC
075841	04/30/92	M5B	22,262	10,108		5.0	MC
075842	04/30/92	M5B	21,365	9,498		5.0	MC
075843	04/30/92	M5B	20,923	9,747		5.0	MC
074127	03/29/92	M5C	22,059	10,203		5.8	BS & MI
073862	03/29/92	M5C	22,902	10,594		5.8	BS & MI
073759	03/29/92	M5C	22,474	10,394		5.8	BS & MI
Total			199,404	91,486		5.4	
1992							
076052	05/13/93	M5A	65,465	13,117	9,055	6.1	BS
076053	05/13/93	M5A		11,410		6.1	BS
076054	05/13/93	M5A		9,907		6.1	BS
076055	04/16/93	M5B	47,979	10,031	9,641	5.6	MI
076056	04/16/93	M5B		9,418		5.6	MI
076057	04/16/93	M5B		9,643		5.6	MI
076058	04/18/93	M5C	44,824	10,194	8,863	4.5	BS
076059	04/18/93	M5C		9,792		4.5	BS
076060	04/18/93	M5C		9,440		4.5	BS
Total			158,268	92,952	27,559	5.5	
1993							
070139	05/12/94	M5A	26,411	8,595	7,700	5.2	BS
070140	05/12/94	M5A	25,686	8,400		5.2	BS
070141	04/14/94	M5B	24,692	9,952	7,827	5.1	MI
070142	04/14/94	M5B	24,906	9,965		5.1	MI
070143	04/11/94	M5C	26,481	10,470	7,718	4.9	BS
070144	04/11/94	M5C	24,922	9,651		4.9	BS
Total			153,098	57,034	23,346	5.1	
1994							
070655	05/12/95	M8A	47,941	19,782	8,908	5.5	BS
070656	04/13/95	M8B	49,983	18,812	8,134	4.7	MI
070657	04/11/95	M8C	48,539	19,290	7,771	5.6	BS
Total			146,463	57,884	24,813	5.3	

Appendix Table A-7 (continued)

Brood year, CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT-tag[a]	Fish per pound	Release location (RM)
1995							
071034	05/09/96	M8A	49,783	20,633	8,896	5.1	TH
071035	04/12/96	M8B	47,543	19,742	8,615	5.1	MI
071036	04/24/96	M8C	49,377	21,205	8,827	5.3	BS
Total			146,703	61,580	26,338	5.3	
1996							
091837[b]	05/15/97	M8A	48,944	20,065	8,655	4.9	BS
091836	04/11/97	M8B	46,788	19,103		4.6	MI
091835[c]	04/10/97	M8C	41,555	19,531		5.4	BS
Total			137,287	58,699	8,655	4.9	
1997							
092339	05/04/98	M8A	47,313	19,468	242	5.5	BS
092340	04/17/98	M8B	49,084	20,646	244	4.7	MI
092341	04/16/98	M8C	41,088	20,800	250	5.9	BS
Total			137,485	60,914	736	5.3	

[a]*All fish were adipose clipped and all CWT fish were also left ventral fin clipped*
[b]*Fish from the 1996 brood were paint marked with orange (1,511), mustard yellow (5,003), and red (2,141) on the anal fin. Fish from the 1997 brood were PIT-tagged.*
[c]*Approximately 5,000 fish were released on 051597.*

Appendix Table A-8. Numbers of spring and fall chinook salmon, coho salmon, and steelhead counted at Three Mile Falls Dam, 1981 to present (chinook subjacks were <381 mm FL; chinook jacks were 382-610 mm FL; coho jacks were 382-508 mm FL).

	Spring chinook salmon			Fall chinook salmon			
Year	Jack	Adult	Total	Subjack	Jack	Adult	Total
1985					79	6	85
1986					407	28	435
1987				195	139	53	387
1988		13	13	1,268	195	91	1,554
1989	96	68	164	65	267	271	603
1990	32	2,158	2,190	618	113	329	1,060
1991	36	1,294	1,330	273	468	522	1,263
1992	3	461	464	0	64	239	303
1993	16	1,205	1,221	15	27	370	412
1994	8	263	271	368	236	688	1,292
1995	108	388	496	338	288	603	1,229
1996	121	2,152	2,273	606	80	646	1,332
1997	4	2,194	2,198	189	207	354	750
1998	20	409	429				
Average	39	1,169	1,004	358	198	323	823

	Steelhead				Coho Salmon		
Run year	Hatchery	Wild	Total	Year	Jack	Adult	Total
1981-82			768	1982			
1982-83			1,264	1982			
1983-84			2,314	1983			
1984-85			3,197	1984			
1985-86			2,885	1985			
1986-87			3,444	1986			
1987-88	165	2,315	2,480	1987	29		29
1988-89	370	2,104	2,474	1988	746	936	1,682
1989-90	245	1,422	1,667	1989	479	4,154	4,633
1990-91	387	724	1,111	1990	515	409	924
1991-92	522	2,247	2,769	1991	189	1,732	1,921
1992-93	616	1,297	1,913	1992	173	356	529
1993-94	345	945	1,290	1993	18	1,531	1,549
1994-95	656	875	1,531	1994	62	984	1,046
1995-96	785	1,296	2,081	1995	53	946	999
1996-97	1,463	1,014	2,477	1996	24	618	642
1997-98	903	862	1,765	1997	137	670	807
Average	587	1,373	2,084		220	1,234	1,342

REPORT B

Fish Health Monitoring and Evaluation

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INTRODUCTION

Monitoring and evaluation of fish health for Umatilla Hatchery production and other releases into the Umatilla River continued for the seventh year of this program. Fall chinook broodstock monitoring continued for the second year at the new Three Mile Dam Adult Facility and at Priest Rapids for the 97 brood year subyearling Umatilla production. This was also the second year that broodstock monitoring for spring chinook salmon was conducted at the new South Fork Walla Walla Facility. Continued cooperative efforts with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR) during spawnings at this facility provided great opportunity for the collection of samples for *Renibacterium salmoninarum* (Rs) analysis of marked spring chinook salmon returning to the Umatilla River. Commitment to sample 100% of the female adult spring chinook salmon used for broodstock at Umatilla Hatchery was possible through cooperative efforts with the U.S. Fish & Wildlife Services Lower Columbia Fish Health Center. Broodstock monitoring of 98 brood year Umatilla summer steelhead was conducted at Minthorn Ponds.

In addition to preliberation examinations at Umatilla Hatchery, fish health monitoring and support for diagnostic services for fish in acclimation ponds along the Umatilla River continued during this report period. Preliberation examinations were conducted at the Imeques C-mem-ini-kem and Thornhollow acclimation sites. A preliberation/increased loss examination was conducted on fall chinook salmon at the Thornhollow acclimation facility. There were no juvenile disease outbreaks or increased loss examinations required at Umatilla Hatchery.

METHODS

During this report period some changes were made to previously described methods (Keefe et al. 1993, Keefe et al. 1994, and Groberg et al. 1996 and 1997). These changes were made based on the history of monitoring at Umatilla Hatchery since its inception in 1991. Changes will be stated under each respective heading to follow.

Juvenile Monthly Monitoring

With the introduction of the new work statement on November 1, 1997 the protocol for monitoring *Renibacterium salmoninarum* was changed for steelhead. Beginning at this time we no longer monitored for Rs levels in steelhead. The protocol for monitoring erythrocytic inclusion body syndrome (EIBS) in moribund and grab-sampled chinook was changed to no longer monitor for EIBS at Umatilla Hatchery. A t-test (Triola 1992) was used to compare log-transformed ELISA optical densities (OD) values of 96 brood year spring chinook salmon in Oregon and Michigan raceways.

Juvenile Preliberation Monitoring

With the introduction of the new work statement on November 1, 1997 the protocol for monitoring for EIBS in grab-sampled chinook was changed to no longer monitor for EIBS at Umatilla Hatchery during preliberation examinations.

Prophylactic Treatments

Juvenile spring chinook salmon were given two prophylactic feedings of Aquamycin under the Investigational New Animal Drug (INAD) process for BKD management. Veterinary prescriptions were obtained for the use of formalin on summer steelhead and spring chinook salmon adults at adult holding facilities for the Umatilla program. Additionally, erythromycin and OTC injections were given to adult spring chinook salmon at Three Mile Dam and the South Fork Walla Walla adult facilities under a prescription. These injections were administered at 10 mg/Kg for both antibiotics. Initial injections were given upon collection at Three Mile Dam and then a second injection was given in mid July for fish that arrived by early July. Only one injection was given to fish arriving after early July.

Broodstock Monitoring

Summer steelhead for the 98 brood production at Umatilla Hatchery were sampled at Minthorn Pond. Adult fall chinook salmon for the 97 brood year subyearling program at Umatilla Hatchery were sampled on November 17, 1997. Beginning with this brood year, samples were taken and analyzed by Washington Department of Fish & Wildlife (WDFW) Fish Health personnel for culturable viruses. No blood smears for EIBS or kidneys were taken for Rs antigen analysis by the ELISA. Also, fall chinook salmon adults for Bonneville Hatchery production were sampled at the Three Mile Dam Adult Facility on November 6, 10, 13, 17, 20, 25 and December 1, 1997. Adult spring chinook salmon for the 98 brood year program at Umatilla Hatchery were sampled at the South Fork Walla Walla Adult Facility on August 18, 25 and September 1, 8 and 15, 1998. Sixteen females for spring chinook 98 brood year program at Umatilla Hatchery were from Ringold Ponds (WDFW) adults spawned at Little White Salmon NFH on September 1, 1998.

RESULTS

Juvenile Monthly Monitoring

Necropsies

Thirty-three moribund/fresh-dead and 46 grab-sampled healthy fish (all stocks combined) were examined for external parasites in wet mounts of body scrapings and gill arches; none were found. As in previous years the vast majority of the gills were in good condition. There were occasional observations of gill aneurysms, motile bacteria and clubbed gill tips.

Systemic infections of *F. psychrophilum* (CWD bacteria) in moribund/fresh-dead fish were detected in kidney cultures of 2/17 (11.8%) summer steelhead, 7/27 (25.9%) subyearling fall chinook salmon and none of the 89 spring chinook examined (Appendix Tables A-4, A-5, and A-6). Yellow pigmented bacterial colonies were detected in gill cultures of moribund/fresh-dead fish in 3/9 (33.3%) summer steelhead, 8/16 (50%) subyearling fall chinook salmon, and 3/73 (4.1%) spring chinook salmon examined (Appendix Tables A-4, A-5, and A-6). These gill bacteria were tested and identified as *F. psychrophilum* in one summer steelhead and one subyearling fall chinook salmon. *Yersinia ruckeri* (Redmouth bacteria) was detected systemically in 1/17 (5.9%) moribund/fresh-dead summer steelhead (Appendix Table A-4).

Gross signs of BKD such as swollen/gray kidney, pale kidney, and kidney pustules were observed upon examining moribund/fresh-dead 96 brood year Carson spring chinook salmon during three of the monthly monitoring examinations (August, November and December 1997). In August 2/9 (22.2%) moribund/fresh-dead fish had gross signs of BKD. In November 3/26 (11.5%) and in December 5/19 (26.3%) moribund/fresh-dead fish were found to have gross signs of BKD. In all cases the fish with gross signs of BKD were found to have clinical levels of Rs antigen (OD $\geq$ 1.000) by the ELISA (Appendix Table A-9). During monitoring up to November, 1997 blood smears from 45 grab-sampled and eight

moribund juvenile chinook salmon were negative for inclusions caused by EIBS. There were no signs of EIBS such as anemia or pale gills.

Assays for *Renibacterium salmoninarum* by the ELISA and DFAT

Kidneys from one moribund and five grab-sampled 97 brood year Umatilla summer steelhead were negative by the direct fluorescent antibody (DFAT) staining method (Appendix Table A-7). The ELISA was used to analyze five moribund/fresh-dead and five grab-sampled steelhead. The optical density (OD) values ranged from 0.000-0.190. After the introduction of the new work statement in November 1997 this aspect of fish health monitoring was dropped.

Twenty-seven moribund/fresh-dead and 10 grab-sampled 97 brood year Priest Rapids fall chinook salmon programmed as subyealings and sampled in April 1998 were negative by the DFAT (Appendix Table A-8).

Eighteen moribund/fresh-dead and 15 grab-sampled 96 brood year Carson spring chinook salmon were examined for the presence of Rs bacteria by the DFAT in June-July 1997. All of the grab-sampled fish were negative, however, 4/18 (22.2%) moribund/fresh-dead fish were positive by the DFAT. The positives included one very high level (4+) positive and a moderate (2+) level positive from raceway O5A. The remaining two positives were low level (1+). ELISA monitoring began in August 1997 when the fish became large enough for this assay. Seventy-one moribund/fresh-dead and 75 grab-sampled fish were tested for the presence of Rs antigen by the ELISA from August-December 1997 (Appendix Table A-9). Two moribund/fresh-dead fish out of nine examined in August had clinical BKD with ELISA values of 2.622 (O5B) and 2.569 (M2A) respectively. During September all six moribund/fresh-dead ELISA values were ≤ 0.022 OD units. In October two of 11 moribund/fresh-dead fish (M2A and M2B) had high ELISA values of 0.687 and 0.775 OD units. For the remainder of the monthly monitoring, November/December 1997, there was an increase in the proportion of moribund/fresh-dead fish that had clinical BKD as determined by the ELISA. Eight of 45 moribund/fresh-dead fish assayed in this time period had ELISA values ≥ 1.000 and one was high level at 0.675 OD units in raceway O4A. Overall proportion and prevalence (%) of clinical BKD as confirmed by the ELISA in moribund/fresh-dead fish in Oregon raceways was 7/32 (21.9%). The overall picture for Michigan raceways was 3/39 (7.7%) at clinical levels. Statistical analysis showed that there were no significant differences between Oregon and Michigan ELISA OD values (P=0.231).

Juvenile Preliberation Monitoring

Necropsies

At Umatilla Hatchery a subsample of grab-sampled fish from all species and stocks were examined for external parasites and gill condition. No parasites were observed on body scrapings and gill mounts from eighteen grab-sampled fish. Overall gill condition was normal with only occasional observations being made of a few gill aneurysms. Thirty 97 brood year summer steelhead smolts, sixty 97 brood year fall chinook salmon subyearlings, and seventy 96 brood year spring chinook salmon yearlings were tested for infectious hematopoietic necrosis virus (IHNV) and any other replicating agents; none were detected.

On February 10, 1998 at Willard NFH, lower Columbia River Fish Health Center personnel examined the fall chinook salmon yearlings destined for the Umatilla River Thornhollow acclimation site. A 12% incidence of BKD was detected by the DFAT staining method in grab-sampled fish. This stock of fish had been experiencing loss from an ongoing BKD epizootic since December 1997. Other results from monitoring this stock and other stocks destined for the Umatilla River can be found in the 1998 lower Columbia River Fish Health Center's annual report to BPA (Gutenberger, 1998).

On March 5, 1998, the Carson 96 brood year spring chinook salmon that had been reared at Umatilla Hatchery were examined at the Imeques C-mem-ini-kem acclimation facility from each of three ponds (P2, P3 and P4). No EIBS was detected in any of the 15 grab-sampled and four moribund fish examined. Gills were in good condition and no parasites were detected. *Flavobacterium psychrophilum* was isolated from kidney smears at low to heavy levels in 4/15 (26.7%) moribund/fresh-dead fish. Gross signs of BKD such as swollen and gray kidney were noted in 2/15 (13.3%) of the fish. Tail rot and external fungus were noted on 5/15 (33.3%) of these fish.

Also on March 5, 1998, at the Imeques C-mem-ini-kem acclimation facility, five grab-sampled and two moribund Carson 96 brood year spring chinook salmon reared at Little White Salmon NFH were negative for EIBS and external parasites. *Flavobacterium psychrophilum* was isolated from kidney smears at low to moderate levels in 3/5 (80%) moribund/fresh-dead fish. Gross signs of BKD were noted in 11/15 (73.3%) moribund/fresh-dead fish.

On April 8, 1998, an additional preliberation examination was conducted at Imeques C-mem-ini-kem on a later release group of Carson 96 brood year spring chinook salmon reared at Little White Salmon NFH (pond 1 and pond 2). EIBS was detected in 2/10 (20%) grab-sampled fish. The protozoan parasite *Ambiphrya* (*Scyphidia*) was detected at low levels on body scrapings of all four grab-sampled fish examined for parasites. *Flavobacterium psychrophilum* was isolated from kidney smears at high levels in 2/10 (20%) moribund/fresh-dead fish. Gross signs of BKD were noted on 9/10 (90%) moribund/fresh-dead fish. Fish from one pond (P4) of Carson 96 brood year spring chinook salmon reared at Carson NFH were also sampled on April 8, 1998. EIBS or external parasites were not detected in five grab-sampled fish. No moribund or fresh dead fish were available from this group.

On March 5, 1998 a preliberation examination was conducted on the 96 brood year Bonneville fall chinook salmon yearlings at the Thornhollow acclimation facility. EIBS or external parasites were not detected in two moribund fish examined. Gross signs of BKD were noted on 6/10 (60%) moribund/fresh dead fish.

On April 1, 1998 a preliberation/increased loss examination was conducted on the 96 brood year fall chinook salmon yearlings at the Thornhollow acclimation facility. These fish were reared at Willard NFH. Ten moribund/fresh-dead fish from each of two ponds (P1 and P2) were examined.

Flavobacterium psychrophilum was isolated from kidney smears at mostly high to moderate levels in 8/20 (40%) of these fish. All twenty had gross signs of clinical BKD.

Assays for *Renibacterium salmoninarum* by the ELISA and DFAT

Thirty grab-sampled Priest Rapids subyearling fall chinook salmon were sampled from each of six Michigan raceways M3 (A,B and C) and M4 (A, B and C). There was no evidence of an Rs infection problem at preliberation. All Rs ELISA values were 0.079 OD units or less (Appendix Table A-10). Statistical analysis of these results was not warranted since the results from each raceway were so similar.

Thirty 96 brood year Carson yearling spring chinook salmon were sampled from each raceway of two Oregon series (O4A and B, and O5A and B) and one Michigan series M2 (A, B and C). In these grab-sampled fish there was no indication of any significant level of Rs infection at pretransfer time from Umatilla Hatchery. One of 210 had a value of 0.122 and the remaining 209 had values of 0.086 OD units or less (Appendix Table A-11). Statistical analysis of these results was not warranted since the results from each raceway were similar.

This same stock was examined at the Imeques C-mem-ini-kem acclimation facility. Five moribund/fresh-dead and five grab-sampled 96 brood year spring chinook salmon smolts were sampled from each of three ponds (P2, P3 and P4). Two of the 15 moribund/fresh-dead fish had gross signs of BKD in kidney tissue and Rs ELISA values ≥1.000 (Appendix Table A-12). All values from the remaining 13 moribund/fresh-dead fish and all 15 grab-sampled fish were 0.051 OD units or less.

Three additional 96 brood year Carson spring chinook salmon preliberation examinations on fish from lower Columbia River facilities were conducted at the Imeques C-mem-ini-kem acclimation facility. Fifteen moribund/fresh-dead and five grab-sampled spring chinook reared at Little White Salmon NFH were examined from one pond (P1) on March 5, 1998. Eleven of 15 (73.3%) moribund/fresh-dead smolts had clinical BKD with values ≥ 1.000 and 1/15 (6.7%) had a high level value of 0.753 OD units, and the remaining three fish had values ≤ 0.083 OD units. All five grab-sampled fish had values ≤ 0.036 OD units (Appendix Table A-13). On April 8, 1998 five moribund/fresh-dead and five grab-sampled smolts of this same stock and rearing location were sampled from each of two ponds (P1 and P2). All five moribund/fresh-dead smolts from Pond 1 and 4/5 (80%) from Pond 2 had clinical BKD with ELISA values ≥ 1.000. All values from grab-sampled fish were ≤ 0.025 OD units (Appendix Table A-14). Also at the Imeques C-mem-ini-kem acclimation facility on April 8, 1998, five grab-sampled 96 brood year Carson spring chinook smolts reared at Carson NFH were found to have all ELISA values ≤ 0.026 OD units (Appendix Table A-15).

At Thornhollow on March 5, 1998, five moribund/fresh-dead and five grab-sampled 96 brood year fall chinook salmon smolts from each of two ponds (P1 and P2) were sampled. These fish were reared at Bonneville Hatchery. Three of five (60%) moribund/fresh-dead fish from each of the ponds had clinical BKD with ELISA values ≥ 1.000 and the remaining fish had values ≤ 0.156 OD units (Appendix Table A-16). One of five (20%) grab-sampled fish from Pond 2 had a clinical value of 1.654 OD units and 1/5 (20%) from both ponds had fish with lower but significant level of Rs antigen at 0.396 and 0.246 OD units respectively. The remaining seven fish had values ≤ 0.084 OD units.

At Thornhollow on April 1, 1998, 10 moribund/fresh-dead 96 brood year fall chinook smolts, reared at Willard NFH were sampled from each of two ponds (P1 and P2). Nineteen of 20 (95%) had gross signs of BKD and clinical ELISA values ≥ 1.000 (Appendix Table A-17).

Prophylactic Treatments

Administration of oral erythromycin (Aquamycin) was once again implemented twice through INAD protocols to the 96 brood year spring chinook salmon programmed as yearlings. This was administered as two 28-day therapeutic feedings at a target dosage of 100 mg/Kg. The first feeding (2.25% erythromycin) started on August 12, 1997 and ended on September 8, 1997. Non-lethal signs of toxicity were observed by hatchery personnel on September 9, 1997 or day one of toxicity testing. Ten of 60 (16.7%) fish displayed arched back and rigid spinal columns while 1/60 (1.7%) displayed bruising or skin discoloration. The only other sign of toxicity for this feeding was on day seven of toxicity testing when 1/60 (1.7%) displayed an arched back and rigid spinal column. The second feeding (4.5% erythromycin) started on December 11, 1997 and ended on January 7, 1998. Lethal and non-lethal signs of toxicity were observed by hatchery personnel during the feeding period and on day one, three and seven of toxicity testing. Fish culture activities such as pond cleaning and fish counts could not be conducted without mortality. Nineteen of 240 (7.9%) fish died with arched back and rigid spinal column during toxicity testing. Twenty-one of 240 (8.8%) fish displayed the same external signs but with no mortality.

Broodstock Monitoring

Kidneys from 15 adult Umatilla summer steelhead mortalities were sampled and analyzed for Rs antigen by the ELISA (Appendix Table A-18). All values were low level at ≤ 0.036 OD units. All 46 males and females sampled were negative for IHNV and any culturable viruses (Appendix Table A-19). External fungus was evident on 4/15 (26.7%) of these mortalities.

Sixty individual female Priest Rapids fall chinook salmon 97 brood year spawners were sampled for IHNV and any culturable viruses; all were negative (Appendix Table A-20).

Seven sub-samples of up to 20 kidneys per spawning were taken from 112 Umatilla fall chinook salmon 97 brood year fish at Three Mile Dam Adult Facility for Rs antigen analysis by the ELISA (Appendix Table A-21). Two of 112 (1.8%) had low level values of 0.112 and 0.106 OD units while the remaining 110 were all ≤ 0.068 OD units. All ten adult mortality had ELISA values ≤ 0.083 OD units (Appendix Table A-22). One hundred thirty-two females were sampled for IHNV and any culturable viruses; all were negative (Appendix Table A-23). Six of 10 (60%) adult mortalities had heavy levels of systemic *A. salmonicida*, the causative agent of furunculosis.

Sixteen Ringold spring chinook salmon 98 brood year fish held and spawned at Little White Salmon NFH were used for Umatilla Hatchery 98 brood year production. Two of these 16 females (12.5%) had moderate level Rs ELISA values of 0.409 and 0.466 OD units (Appendix Table A-24). Three of 16 (18.8%) were in the low 0.200-0.399 value range and the remaining 11 were all ≤ 0.183 OD units. Infectious Hematopoietic Necrosis Virus (IHNV) was isolated from 30/81 (37%) females and 8/21 (38.1%) males that were sampled on September 1, 1998 (Appendix Table A-25).

One hundred twenty-four Umatilla River spring chinook salmon 98 brood year spawners, two killed-not-spawned fish and eighteen mortalities were sampled for Rs antigen by the ELISA (Appendix Tables A-26 and A-27). Of the 96 spawned females, one had a value of 0.338 OD units and four were in the 0.100-0.199 value range and the remaining 91 were all ≤ 0.067 OD units. All 28 male Rs ELISA values were ≤ 0.130 OD units. One killed-not-spawned female had a small kidney lesion and a ELISA value of 2.387 and the other had a value of 0.015 OD units. None of the eighteen mortalities died from

BKD since all ELISA values were ≤ 0.058 OD units. Fifty-four individual ovarian fluid samples and pyloric caeca/kidney/spleen tissue samples from 60 fish were sampled for IHNV and any culturable viruses; all were negative (Appendix Table A-28). One of 18 (5.6%) adult mortalities had a heavy level of systemic *A. salmonicida*, the causative agent of furunculosis.

Code wire tag recovery data was used to track the Rs antigen levels of 43 adult spring chinook salmon spawned at the South Fork Walla Walla Facility in 1998 back to rearing location or rearing strategy (Appendix Table A-29). Twenty-two of these 43 (51.2%) returning fish were reared at Bonneville Hatchery and had ELISA values ≤ 0.145 OD units. Eleven were reared in Oregon raceways at Umatilla Hatchery with one having a clinical value of 2.387; the remaining 10 fish had ELISA values ≤ 0.049. Eight were reared in Michigan raceways and all had ELISA values ≤ 0.028 OD units. Two were strays into the Umatilla River system and had ELISA values ≤ 0.031.

DISCUSSION

This seventh year of monitoring has supported previous years conclusions regarding the total absence of parasites and viruses under the fish culture conditions at Umatilla Hatchery since its inception. The information gained during this report period has added to the continued development of juvenile and adult pathogen and disease profiles and stock histories valuable to future planning and management for a successful hatchery component to the overall Umatilla Basin fish restoration efforts. The collective information from the past seven years has now allowed for adjustments to protocols used for fish health monitoring and evaluation. These adjustments such as dropping monitoring for EIBS and Rs infection levels in steelhead have come after years of data collection proving the lack of usefulness to continue this at Umatilla Hatchery.

Returning Umatilla River adult spring chinook salmon have now been monitored for Rs by the ELISA for two brood years at the South Fork Walla Walla Facility. So far this stock has proven to be mostly "clean" in terms of significant levels of Rs antigen. No clinical BKD was present in 1997 (Groberg et al. 1999) and only one female had gross signs of BKD and determined to be clinically infected by the ELISA in 1998 (Appendix Table A-26). This female was not used for broodstock which kept the 1998 spring chinook progeny free from heavy loads of potential vertically transmitted Rs to the next generation from this female. Vertical transmission (female parent to progeny) of Rs is a well documented mechanism of perpetuating this within salmonid populations (Fryer et al. 1993).

Efforts were made to determine the effect of rearing strategy on levels of Rs antigen and success in adult spring chinook returning to the Umatilla River. Infection levels in all but one of the 43 analyzed adults had only low or negative infection levels. One of the returning adults from an Oregon raceway had a clinical level of Rs antigen (Appendix table A-29). This was most likely a four year old returning adult from 1994 releases. The Carson 1994 brood year fish had experienced BKD losses at Umatilla Hatchery (Groberg et al. 1998). The available data to date has made comparisons of Rs infection levels between Michigan and Oregon reared juveniles returning as adults difficult because of low numbers and thus far there has been a failure to see a high degree of adults from years with BKD problems return to spawning with significant levels of Rs antigen. This could be accounted for by losses during outmigration or at any stage of life at sea or some unknown mechanism. *Renibacterium salmoninarum* is thought to persist in fish populations because Rs has the ability to survive intracellularly within mononuclear phagocytes (Gutenberger et al. 1997).

The low level of BKD mortality (defined as clinical DFAT of 4+ or ELISA values ≥ 1.000) experienced by the 96 brood year Carson spring chinook juveniles (Appendix Table A-9) was most likely vertical transmission of Rs from 96 brood year Carson adults. The 1996 Carson adults spawned at Little White Salmon NFH were found to have six clinical level BKD females (Groberg et al. 1998). The real number of clinical BKD females is unknown because 100% sampling of females for Rs infection levels had not yet been implemented in 1996. I believe this highlights the importance of complete sampling of broodstocks for Rs infection levels. The pattern certainly is becoming clearer in the Umatilla Hatchery program and that is as follows: when chinook broodstocks are used with known clinical BKD females the progeny either have low grade BKD loss or increased loss due to BKD. The recent direction this program has taken to join the practice of 100% sampling of females for Rs antigen levels will help in reducing the impact of BKD on subsequent generations by providing opportunity to implement segregation rearing strategies if needed and/or the culling of eggs, based on the level of Rs in the female parent (Pascho et al. 1991).

The first isolation of *Y. ruckeri*, the bacteria that causes enteric redmouth disease, in 97 brood summer steelhead highlights the need for continued surveillance for potential problems (Appendix Table A-4). This bacteria is known to be present in the environment and can be recovered from a variety of sources; steelhead are a known host species (Bullock 1984). Since these fish are on well water the source of this bacteria must have been by birds or some other route into the pond which is certainly possible with the Columbia River being so close in proximity. Isolations of *F. psychrophilum* (CWD bacteria) in summer steelhead (Appendix Table A-4) and subyearling fall chinook (Appendix Table A-5) should remind fish culturists and fisheries managers of the continual potential impact this bacteria could have and indeed has had (1992 and 1996 annual reports) in causing CWD outbreaks at this facility.

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Appendix Table A-1. Number of 97 brood year Umatilla summer steelhead juveniles sampled per raceway in Oregon raceway O2A and Michigan series M8 (A, B and C) during monthly monitoring.

Date sampled	O2A[1]	O2A[2]	M8A[1]	M8B[1]	M8C[1]
08-97	1	5			
09-97	5	5			
10-97	ND[4]	ND[4]			
11-97			2	3	1
12-97			1	ND[3]	2
01-98			1	ND[3]	1
02-98			ND[3]	2	1

[1]*Moribund or fresh-dead fish.*
[2]*Normal, healthy appearing fish.*
[3]*Indicates not done (ND) because no moribund or fresh-dead fish were available.*
[4]*Indicates not done (ND) because fish were being transferred to Michigan raceways during monthly monitoring, no normal mortality.*

Appendix Table A-2. Number of 97 brood year Priest Rapids fall chinook salmon juveniles, released as subyearlings, sampled per raceway in the Michigan series M1 and M3 (A, B and C) during monthly monitoring.

Date sampled	M1A[1]	M1B[1]	M1C[1]	M1C[2]	M3A[1]	M3B[1]	M3C[1]	M3C[2]
04-98	4	5	5	5	5	5	3	5

[1]*Moribund or fresh-dead fish.*
[2]*Normal, healthy appearing fish.*

Appendix Table A-3. Number of 96 brood year Carson spring chinook salmon juveniles, released as yearlings, sampled per raceway in Oregon series O3A, O4 and O5 (A and B), and Michigan series M2 (A, B, and C) during monthly monitoring.

Date sampled	O3A[1]	O3A[2]	O4A[1]	O4B[1]	O4B[2]	O5A[1]	O5A[2]	O5B[1]	O5B[2]	M2A[1]	M2B[1]	M2C[1]	M2C[2]
06-97						10	5						
07-97	2	5				6	5						
08-97			1	1	5	2		1	5	1	2	1	5
09-97			ND[3]	ND[3]	5	ND[3]		1	5	2	1	2	5
10-97			2	1	5	1		1	5	2	3	1	5
11-97			4	1	5	2		4	5	5	5	5	5
12-97			1	3	5	2		4	5	1	5	3	5

[1]*Moribund or fresh-dead fish.*
[2]*Normal, healthy appearing fish.*
[3]*Indicates not done (ND) because no moribund or fresh-dead fish were available*

Appendix Table A-4. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh-dead 97 brood year Umatilla summer steelhead during monthly juvenile fish health monitoring. Unless indicated otherwise, the prevalence was 0%.

Date sampled	Raceway	Systemic bacteria[1]			Gill bacteria[2]
		F. psychrophilum[3]	*Y. Ruckeri*[6]	APS	
08-97	O2A	0/1	0/1	1/1 (100%)	0/1
09-97	O2A	0/5	0/5	5/5 (100%)	ND[4]
11-97	M8A	0/2	0/2	0/2	1/2 (50%)
	M8B	0/3	0/3	1/3 (33%)	ND[4]
	M8C	1/1 (100%)[3]	0/1	0/1	1/1 (100%)
12-97	M8A	1/1 (100%)[5]	0/1	0/1	1/1 (100%)[3]
	M8C	0/2	1/2 (50%)[6]	1/2 (50%)	0/2
01-98	M8A	0/1	0/1	0/1	0/1
	M8C	0/1	0/1	0/1	0/1

[1] *Systemic bacteria isolated from kidney smear inocula were Flavobacterium psychrophilum, Yersinia ruckeri and aeromonad-pseudomonad (APS) types.*
[2] *These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.*
[3] *These isolates were tested by the rapid slide agglutination test using F. psychrophilum polyclonal rabbit antiserum.*
[4] *Indicates not done (ND) because no moribund or fresh-dead fish were available.*
[5] *This isolate was cultured from a skin lesion and confirmed by the rapid slide agglutination test using F. psychrophilum polyclonal rabbit antiserum. The kidney culture was negative.*
[6] *This isolate was tested using Y. ruckeri polyclonal rabbit antiserum.*

Appendix Table A-5. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh-dead 97 brood year Priest Rapids fall chinook salmon, released as subyearlings, during monthly juvenile fish health monitoring. Unless indicated otherwise, the prevalence was 0%.

Date sampled	Raceway	Systemic bacteria[1]		Gill bacteria[2]
		F. psychrophilum	APS	
04-98	M1A	1/4 (25%)	1/4 (25%)	0/1
	M1B	1/5 (20%)	3/5 (60%)	ND[4]
	M1C	1/5 (20%)	2/5 (40%)	1/2 (50%)
	M3A	1/5 (20%)	0/5	4/5 (80%)
	M3B	3/5 (60%)[3]	3/5 (60%)	3/5 (60%)[3]
	M3C	0/3	0/3	0/3

[1] *The only systemic bacteria isolated from kidney smear inocula were* Flavobacterium psychrophilum *and aeromonad-pseudomonad (APS) types.*

[2] *These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.*

[3] *One of these three isolates was determined to be* F. psychrophilum *by the rapid slide agglutination test using* F. psychrophilum *polyclonal rabbit antiserum.*

[4] *Indicates not done (ND) because no moribund or fresh-dead fish were available.*

Appendix Table A-6. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh-dead 96 brood year Carson spring chinook salmon, released as yearlings, during monthly juvenile fish health monitoring. Unless indicated otherwise, the prevalence was 0%.

Date sampled	Raceway	Systemic bacteria[1]		Gill bacteria[2]
		F. psychrophilum	APS	
06-97	O5A	0/10	2/10 (20%)	0/3
07-97	O3A	0/6	4/6 (67%)	0/4
	O5A	0/2	2/2 (100%)	0/2
08-97	O4A	0/1	0/1	ND[3]
	O4B	0/1	0/1	0/1
	O5A	0/2	0/2	0/2
	O5B	0/1	1/1 (100%)	0/1
	M2A	0/1	1/1 (100%)	ND[3]
	M2B	0/2	0/2	0/2
	M2C	0/1	0/1	0/1
09-97	O5B	0/1	0/1	0/1
	M2A	0/2	2/2 (100%)	0/1
	M2B	0/1	1/1 (100%)	0/1
	M2C	0/2	2/2 (100%)	0/2
10/97	O4A	0/2	0/2	0/2
	O4B	0/1	0/1	0/1
	O5A	0/1	1/1 (100%)	ND[3]
	O5B	0/1	0/1	ND[3]
	M2A	0/2	1/2 (50%)	1/2 (50%)
	M2B	0/3	0/3	1/3 (33%)
	M2C	0/1	0/1	1/1 (100%)
11-97	O4A	0/4	2/4 (50%)	0/2
	O4B	0/1	0/1 (100%)	0/1
	O5A	0/2	0/2	0/2
	O5B	0/4	1/4 (25%)	0/4
	M2A	0/5	0/5	0/5
	M2B	0/5	0/5	0/5
	M2C	0/5	1/5 (20%)	0/5

[1]*The only systemic bacteria isolated from kidney smear inocula were aeromonad-pseudomonad (APS) types.*

[2]*These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.*

[3]*Indicates not done (ND) because no moribund or fresh-dead fish were available.*

Appendix Table A-6. Continued.

Date sampled	Raceway	Systemic bacteria[1]		Gill bacteria[2]
		F. psychrophilum	APS	
12-97	O4A	0/1	1/1 (100%)	0/1
	O4B	0/3	1/3 (33%)	0/3
	O5A	0/2	1/2 (50%)	0/2
	O5B	0/4	3/4 (75%)	0/4
	M2A	0/1	0/1	0/1
	M2B	0/5	2/5 (40%)	0/5
	M2C	0/3	2/3 (67%)	0/3

Appendix Table A-7. DFAT results and ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 97 brood year Umatilla summer steelhead juveniles sampled during monthly monitoring from Oregon raceway O2A. Monitoring for *Renibacterium salmoninarum* was performed for two months, until the introduction of the new work statement in November 1997.

Date sampled	ELISA OD_{405}	
	O2A[2]	O2A[3]
08-97	0/1[4]	0/5[4]
09-97	.000	.008
	.008	.010
	.019	.017
	.026	.018
	.190	.038
10-97	ND[5]	ND[5]

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:15 weight/volume dilution for ELISA.*

[2] *Moribund or fresh-dead fish.*

[3] *Normal, healthy appearing fish.*

[4] *Examined by the DFAT because of the small fish size.*

[5] *Indicates not done (ND) because fish were being transferred to Michigan raceways during monthly monitoring, no normal mortality.*

Appendix Table A-8. Number of 97 brood year Priest Rapids fall chinook salmon juveniles, released as subyearlings, assayed by the DFAT for *Renibacterium salmoninarum* during monthly monitoring from the Michigan series, all were negative.

Date sampled	M1A[1]	M1B[1]	M1C[1]	M1C[2]	M3A[1]	M3B[1]	M3C[1]	M3C[2]
04-98	4	5	5	5	5	5	3	5

[1]*Moribund or fresh-dead fish.*
[2]*Normal, healthy appearing fish.*

Appendix Table A-9. DFAT results and ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 96 brood year Carson spring chinook salmon juveniles, released as yearlings, sampled during monthly monitoring from Oregon series O3A, O4 (A and B), O5 (A and B), and Michigan series M2 (A, B, and C).

	ELISA OD_{405}												
Date sampled	O3A[2]	O3A[3]	O4A[2]	O4B[2]	O4B[3]	O5A[2]	O5A[3]	O5B[2]	O5B[3]	M2A[2]	M2B[2]	M2C[2]	M2C[3]
6-97						3/10[5]	0/5						
7-97	0/2	0/5				1/6[5]	0/5						
8-97			.064	.065	.008	.005		2.622	.005	2.569	.006	.015	.011
					.009	.008			.009		.033		.014
					.011				.016				.019
					.030				.027				.020
					.038				.047				.027
9-97					.007			.007	.007	.013	.018	.004	.011
					.013				.014	.018		.022	.013
					.014				.014				.017
					.014				.015				.024
					.023				.022				.028

[1] *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 or 1:15 weight/volume dilution for the ELISA.*

[2] *Moribund or fresh-dead fish.*

[3] *Normal, healthy appearing fish.*

[4] *Examined by the DFAT because of the small fish size.*

[5] *One of the four positives rated at the 4+ level for* R. salmoninarum*, one at the 2+ level and two at the 1+ level.*

Appendix Table A-9 Continued.

	ELISA OD_{405}												
Date sampled	O3A[2]	O3A[3]	O4A[2]	O4B[2]	O4B[3]	O5A[2]	O5A[3]	O5B[2]	O5B[3]	M2A[2]	M2B[2]	M2C[2]	M2C[3]
10-97			.017	.026	.007	.016		.014	.014	.028	.009	.017	.016
			.021		.007				.016	.687	.012		.017
					.013				.018		.775		.018
					.013				.019				.055
					.018				.023				.220
11-97			.008	2.525	.016	.006		.012	.014	.011	.003	.007	.018
			.012		.020	2.175		.039	.014	.014	.010	.010	.022
			.020		.022			.065	.014	.023	.012	.019	.031
			.675		.024			2.739	.016	.025	.029	.020	.032
					.028				.022	.028	.031	.038	.037
12-97			.035	.021	.013	.007		.011	.013	.029	.017	.069	.015
				2.031	.014	.048		.016	.015		.032	.100	.018
				2.802	.014			.019	.015		.057	1.327	.021
					.032			2.549	.016		.072		.026
					.035				.022		3.116		.028

Appendix Table A-10. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 30 Priest Rapids 97 brood year fall chinook salmon juveniles per raceway, released as subyearlings from Michigan series M3 (A, B, and C) and M4 (A, B, and C). Means and ranges for each raceway are shown below the 30 individual sample readings. All raceways were sampled on 05-06-98 at a mean body weight of 4.6 gms/fish.

Sample number	ELISA OD_{405}					
	M3A	M3B	M3C	M4A	M4B	M4C
01	.002	.007	.007	.005	.005	.007
02	.002	.008	.008	.005	.005	.008
03	.003	.008	.009	.007	.005	.010
04	.005	.008	.009	.007	.007	.010
05	.005	.009	.009	.008	.008	.011
06	.006	.010	.010	.009	.008	.012
07	.006	.010	.010	.009	.009	.012
08	.006	.010	.010	.009	.009	.013
09	.007	.011	.011	.009	.009	.013
10	.008	.011	.012	.010	.011	.013
11	.008	.014	.013	.010	.012	.013
12	.008	.014	.013	.010	.012	.013
13	.009	.015	.013	.011	.012	.014
14	.009	.017	.013	.011	.013	.014
15	.009	.018	.013	.011	.015	.015
16	.011	.018	.013	.012	.015	.015
17	.011	.019	.014	.013	.016	.015
18	.011	.020	.014	.013	.016	.016
19	.011	.021	.015	.014	.016	.016
20	.014	.021	.015	.016	.018	.016
21	.014	.024	.016	.016	.018	.016
22	.014	.024	.016	.016	.019	.016
23	.017	.024	.016	.016	.019	.016
24	.020	.024	.018	.016	.019	.017
25	.021	.026	.019	.019	.019	.021
26	.021	.028	.020	.019	.020	.021
27	.025	.029	.020	.021	.021	.021
28	.026	.030	.021	.022	.023	.023
29	.027	.030	.029	.029	.028	.024
30	.041	.033	.030	.030	.073	.079
Mean	.013	.018	.015	.013	.016	.017
Range	.002-.041	.007-.033	.007-.030	.005-.030	.005-.073	.007-.079

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:15 weight/volume dilution for ELISA.*

Appendix Table A-11. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 30 Carson 96 brood year spring chinook salmon juveniles from Oregon series O4 (A and B) and O5 (A and B), and Michigan series M2 (A, B, and C). Means and ranges for each raceway are shown below the 30 individual sample readings. Fish were sampled on 01-22-98 at a mean body weight of 40.0 gms/fish.

Sample number	ELISA OD_{405}						
	O4A	O4B	O5A	O5B	M2A	M2B	M2C
01	.005	.007	.004	.006	.007	.008	.005
02	.007	.008	.005	.007	.008	.009	.010
03	.009	.008	.008	.007	.009	.009	.010
04	.011	.010	.008	.007	.011	.010	.010
05	.011	.010	.009	.009	.013	.010	.011
06	.012	.012	.009	.011	.013	.011	.012
07	.012	.013	.010	.011	.014	.011	.012
08	.013	.013	.012	.012	.014	.012	.012
09	.013	.013	.013	.013	.015	.013	.012
10	.014	.015	.013	.013	.015	.013	.013
11	.014	.015	.013	.013	.015	.015	.013
12	.014	.015	.014	.015	.016	.016	.016
13	.014	.016	.015	.015	.016	.016	.016
14	.015	.016	.016	.017	.016	.016	.016
15	.015	.018	.016	.018	.016	.017	.017
16	.015	.019	.016	.019	.016	.017	.017
17	.016	.019	.017	.019	.016	.018	.017
18	.017	.019	.017	.020	.016	.018	.017
19	.017	.020	.018	.020	.017	.019	.019
20	.017	.020	.018	.021	.017	.020	.019
21	.017	.021	.019	.022	.019	.020	.019
22	.017	.021	.019	.022	.020	.020	.019
23	.018	.021	.019	.023	.022	.020	.023
24	.019	.022	.019	.025	.022	.021	.023
25	.020	.023	.022	.026	.023	.023	.029
26	.020	.023	.027	.028	.027	.024	.031
27	.021	.028	.028	.030	.029	.025	.034
28	.030	.029	.038	.040	.032	.027	.039
29	.052	.031	.040	.050	.039	.059	.044
30	.122	.031	.044	.065	.056	.086	.065
Mean	.020	.018	.018	.020	.019	.020	.020
Range	.005-.122	.007-.031	.004-.044	.006-.065	.007-.056	.008-.086	.005-.065

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*

Appendix Table A-12. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from five moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) Carson 96 brood year spring chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 03-05-98 and were reared at Umatilla Hatchery.

Pond 2		Pond 3		Pond 4	
Mt/Mb	He	Mt/Mb	He	Mt/Mb	He
.006	.010	.016	.008	.015	.016
.010	.011	.016	.025	.023	.020
.017	.011	.022	.034	.026	.025
.023	.012	.042	.037	.026	.030
2.535	.035	2.250	.039	.035	.051

[1]*Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*

Appendix Table A-13. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from fifteen moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) Carson 96 brood year spring chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 03-05-98 and were reared at Little White Salmon NFH.

Pond 1	
Mt/Mb	He
.020	.009
.037	.018
.083	.020
.753	.021
1.748	.036
2.066	
2.099	
2.280	
2.295	
2.500	
2.504	
2.607	
2.658	
2.722	
2.764	

[1]*Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*

Appendix Table A-14. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from five moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) Carson 96 brood year spring chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 04-08-98 and were reared at Little White Salmon NFH.

Pond 1		Pond 2	
Mt/Mb	He	Mt/Mb	He
2.089	.008	.018	.008
2.113	.009	2.001	.011
2.127	.009	2.035	.012
2.277	.022	2.046	.014
2.320	.025	2.085	.015

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*

Appendix Table A-15. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from five grab-sampled (He) Carson 96 brood year spring chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 04-08-98 and were reared at Carson NFH. Moribund or fresh-dead fish were not available for sampling.

Pond 4
He
.011
.017
.019
.021
.026

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*

Appendix Table A-16. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 5 moribund/fresh-dead (Mt/Mb) and 5 grab-sampled (He) Bonneville 96 brood year fall chinook salmon juveniles, released as yearlings, from Thornhollow acclimation ponds. Moribund/fresh-dead fish were sampled on 03-05-98 by pathology, and grab-sampled fish were sacrificed on 03-13-98 by research. Fish were reared at Bonneville Hatchery.

Pond 1		Pond 2	
Mt/Mb	He	Mt/Mb	He
.013	.037	.058	.022
.039	.044	.156	.035
1.989	.051	1.033	.040
2.062	.084	1.769	.246
2.156	.396	1.885	1.654

[1]*Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*

Appendix Table A-17. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 10 moribund/fresh-dead (Mt/Mb) 96 brood year fall chinook salmon juveniles, released as yearlings, from Thornhollow acclimation ponds. Fish were sampled on 04-01-98 and were reared at Willard NFH.

Pond 1	Pond 2
Mt/Mb	Mt/Mb
.738	1.722
1.115	2.180
2.508	2.254
2.630	2.255
2.636	2.391
2.637	2.402
2.639	2.434
2.697	2.542
2.745	2.644
2.800	2.661

[1]*Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*

Appendix Table A-18. ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from fifteen Umatilla summer steelhead adult mortalities in 1998.

Sample number	ELISA OD_{405}
01	.015
02	.018
03	.018
04	.020
05	.020
06	.023
07	.023
08	.024
09	.024
10	.025
11	.026
12	.031
13	.031
14	.032
15	.036

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*

Appendix Table A-19. Date and number of samples for culturable viruses from Umatilla summer steelhead spawned in 1998 for Umatilla 98 brood year production. Samples for culturable viruses were taken as individual ovarian fluid (OF) and milt (M) samples, and three-fish pooled pyloric caeca/kidney/spleen (PKS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date sampled	OF	M	PKS
04-08-98	8	10	3
04-15-98	6	6	2
04-22-98	7	8	3
04-29-98	6	6	ND[1]
05-06-98	6	5	2
05-13-98	4	4	2
05-20-98	8	6	3
05-27-98	1	1	1

[1] *Indicates not done (ND).*

Appendix Table A-20. Date and number of samples for culturable viruses[1] from Priest Rapids fall chinook salmon spawned in 1997 for Umatilla Hatchery 97 brood year production. Samples for culturable viruses were taken as five-fish pooled ovarian fluid (OF) and kidney/spleen (KS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date sampled	OF	KS
11-17-97	12	12

[1] *These analyses were done and data provided by Washington Department of Fish & Wildlife (WDFW) Fish Health personnel.*

Appendix Table A-21. ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of 112 kidney samples[1] from Umatilla fall chinook salmon spawned at Three Mile Dam Adult Facility in 1997 for Bonneville 97 brood year production.

Date sampled	ELISA OD_{405}	Date sampled	ELISA OD_{405}
11-06-97	.010	11-13-97	.005
	.014		.007
	.015		.010
	.016		.012
	.016		.012
	.016		.015
	.017		.017
	.018		.019
	.021		.019
	.021		.020
	.023		.025
	.023		.026
	.025		.027
	.027		.027
	.028		.031
	.028		
	.030		
	.032		
	.034		
	.049		
11-10-97	.011	11-17-97	.010
	.011		.011
	.014		.011
	.015		.012
	.015		.013
	.016		.013
	.016		.015
	.016		.015
	.016		.019
	.018		.022
	.019		.022
	.020		.024
	.023		.048
	.024		.068
	.025		
	.028		
	.030		
	.035		
	.042		
	.046		

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*

Appendix Table A-21. Continued.

Date sampled	ELISA OD_{405}	Date sampled	ELISA OD_{405}
11-20-97	.015	12-1-97	.018
	.017		.020
	.017		.021
	.019		.027
	.021		.027
	.023		.028
	.025		.045
	.027		.106
	.027		
	.028		
	.029		
	.041		
	.041		
	.041		
	.145		
11-25-97	.010		
	.012		
	.014		
	.015		
	.016		
	.016		
	.017		
	.017		
	.017		
	.018		
	.020		
	.020		
	.025		
	.026		
	.028		
	.029		
	.048		
	.048		
	.057		
	.068		

Appendix Table A-22. ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 10 Umatilla fall chinook salmon adult mortalities in 1997 at Three Mile Dam Adult Facility.

Sample number	ELISA OD_{405}
01	.013
02	.029
03	.033
04	.043
05	.055
06	.055
07	.057
08	.061
09	.079
10	.083

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*

Appendix Table A-23. Date and number of samples for culturable viruses from Umatilla fall chinook salmon spawned at Three Mile Dam Adult Facility in 1997 for Bonneville 97 brood year production. Culturable viruses were sampled for as individual ovarian fluid (OF) and four-fish pooled pyloric caeca/kidney/spleen (PKS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date Sampled	OF	PKS
11-06-97	21	9
11-10-97	20	6
11-13-97	15	0
11-17-97	14	0
11-20-97	15	0
11-25-97	20	0
12-01-97	8	0

Appendix Table A-24. ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of 16 kidney samples[1] from Ringold spring chinook salmon female adults spawned on September 1, 1998 at Little White Salmon NFH and used for Umatilla Hatchery 98 brood year production.

Female number	ELISA OD_{405}[2]
513	.095
549	.100
511	.101
498	.108
561	.123
516	.125
564	.129
507	.145
531	.164
495	.181
559	.183
489	.253
500	.287
482	.304
543	.409
479	.466

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*
[2] *These analysis were done by personnel from the US Fish & Wildlife Services Lower Columbia River Fish Health Center.*

Appendix Table A-25. Date and number of samples for culturable viruses[1] from Ringold spring chinook salmon spawned at Little White Salmon NFH in 1998 for Umatilla Hatchery 98 brood year production. Samples for culturable viruses were taken as individual ovarian fluid (OF) and male spleen/kidney/gill (SKG) samples.

	Proportion (%) IHNV Positive	
Date sampled	OF	SKG
09-01-98	30/81 (37.0)	8/21 (38.1)

[1] *These analyses were done and data provided by personnel from the US Fish & Wildlife Services Lower Columbia River Fish Health Center.*

Appendix Table A-26. ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of 126 kidney samples[1] from Umatilla River spring chinook salmon male and female adults spawned and killed-not-spawned[2] in 1998 at South Fork Walla Walla Adult Facility for Umatilla Hatchery 98 brood year production.

Date sampled	ELISA OD_{405} Female	ELISA OD_{405} Male
08-18-98	.009	.012
	.015[2]	.015
	.020	.017
	.026	
08-25-98	.007	.005
	.010	.006
	.011	.007
	.011	.007
	.012	.007
	.012	.007
	.012	.009
	.012	.015
	.014	.026
	.014	.130
	.014	
	.016	
	.018	
	.018	
	.019	
	.019	
	.020	
	.021	
	.021	
	.026	
	.026	
	.027	
	.031	
	.039	
	.047	
	.050	
	.338	

[1]*Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*
[2]*These females were killed-not-spawned.*

Appendix Table A-26. Continued.

Date Sampled	ELISA OD_{405} Female	ELISA OD_{405} Male
09-01-98	.012	.008
	.012	.009
	.013	.013
	.013	.014
	.013	.014
	.013	.015
	.014	.021
	.014	.026
	.015	.027
	.015	.029
	.016	.039
	.016	.049
	.016	
	.017	
	.017	
	.017	
	.018	
	.019	
	.019	
	.019	
	.019	
	.021	
	.021	
	.021	
	.021	
	.022	
	.022	
	.023	
	.023	
	.023	
	.023	
	.024	
	.024	
	.024	
	.025	
	.025	
	.025	
	.026	
	.028	

Appendix Table A-26. Continued.

Date Sampled	ELISA OD_{405} Female	Male
	.028	
	.029	
	.030	
	.030	
	.031	
	.031	
	.031	
	.032	
	.033	
	.035	
	.036	
	.038	
	.039	
	.043	
	.067	
	.105	
	.138	
	.145	
	2.387[2]	
09-08-98	.018	.019
	.019	.028
	.020	
	.026	
	.027	
	.029	
	.042	
	.146	
09-15-98	.023	.015

Appendix Table A-27. ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 18 Umatilla River spring chinook salmon adult mortalities in 1998 at South Fork Walla Walla Adult Facility for Umatilla Hatchery 98 brood year production.

Sample number	ELISA OD_{405}	Sample number	ELISA OD_{405}
01	.010	11	.026
02	.011	12	.028
03	.012	13	.031
04	.013	14	.041
05	.014	15	.043
06	.017	16	.046
07	.018	17	.055
08	.022	18	.058
09	.022		
10	.026		

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*

Appendix Table A-28. Date and number of samples for culturable viruses from Umatilla River spring chinook salmon in 1998 at South Fork Walla Walla Adult Facility for Umatilla Hatchery 98 brood year production. Samples for culturable viruses were taken as individual ovarian fluid (OF) and either, two-fish[1], three-fish[2], or four-fish[3] pooled pyloric caeca/kidney/spleen (PKS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date Sampled	OF	PKS
08-18-98	3	1[2]
08-25-98	22	7[3]
09-01-98	20	8[1,3]
09-08-98	8	0
09-15-98	1	0

Appendix Table A-29. ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 43 adult spring chinook salmon male and female adults spawned in 1998 at South Fork Walla Walla Adult Facility for Umatilla Hatchery 98 brood year production. These fish were sampled between August 18 and September 15, 1998 and were identified by origin, either Bonneville Hatchery, Umatilla Hatchery or unknown, using coded wire tag recovery data. All fish were identified as 93 and 94 brood year fish. For Umatilla Hatchery, the type of rearing raceway, Oregon (OR) or Michigan (MI), is indicated.

ELISA OD_{405}			
Bonneville Hatchery	Umatilla Hatchery		Other Origin
	OR	MI	
.007	.005	.015	.021[3]
.007	.008	.016	.031[4]
.007	.009	.018	
.007	.014	.019	
.012	.015	.021	
.013	.017	.021	
.014	.018	.028	
.018	.019	.028	
.019	.036		
.023	.049		
.024	2.387[2]		
.024			
.025			
.026			
.026			
.027			
.029			
.030			
.039			
.067			
.130			
.145			

[1]*Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*
[2]*These fish were killed, but not spawned.*
[3]*This fish released from Powell rearing pond (IDFG).*
[4]*This fish released from Tucannon Hatchery (WDFW).*